OCTOBER 1956

Power Engineering

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Safe, Tight ...Trouble-free

. . . with *union* body-bonnet joint on 125 lb., 150 lb., 200 lb. pressure classes

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Union ring nut provides safety-tight body-bonnet joint

The separate union nut seals the bonnet and body mating surfaces, effecting a tight, leak-proof joint. Possibility of distorting body and bonnet during disassembly and assembly and of loosening the joint during operation are virtually eliminated.

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Fluorescent-penetrant examination detects surface defects. Pipe exterior is painted with fluorescent-fluid, then dusted with powder which draws fluid to surface where it is observed under ultra-violet light.

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which contributes to
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PIPING

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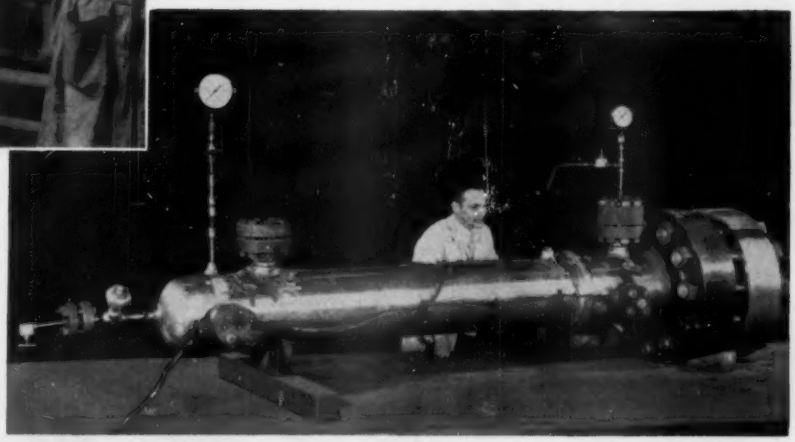
Close quality control is maintained throughout the fabricating process at Pittsburgh Piping by means of almost a score of different types of tests and examinations — three of which are shown on this page. Our technical staff supervises these procedures — checks all materials and production operations. This activity assures that each component, assembly, and the final piping system fabricated and erected by Pittsburgh Piping meets code and insurance requirements . . . fills the customer's specifications . . . and gives trouble-free service.



Hydrostatic testing at Pittsburgh Piping. This stainless steel surge tank is being tested at pressure up to 5,600 psi. Strain gauges are used to check closely for plastic deformation.

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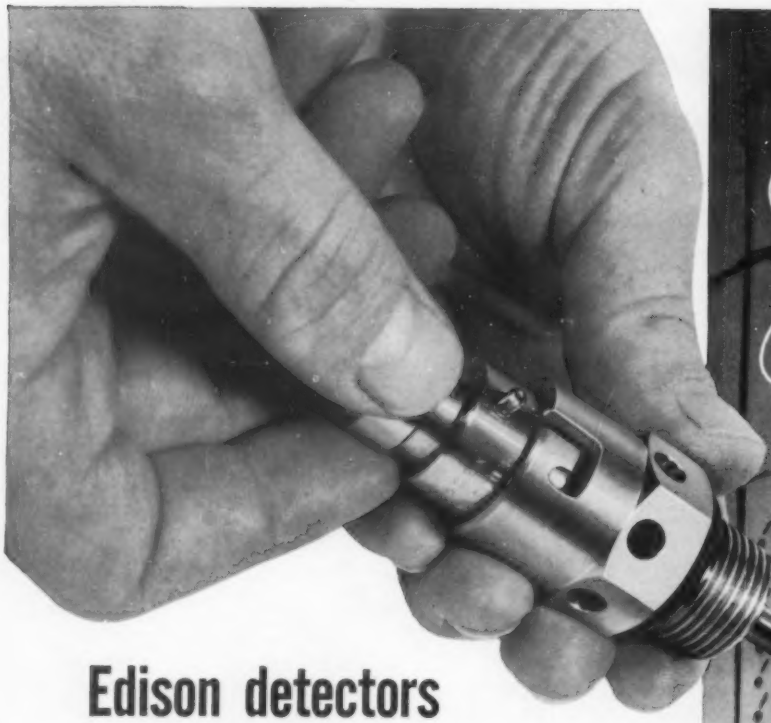

Edison detectors give speedy warning of overheat in atomic pile

Self-monitor design assures fail safe operation

New Edison Resistance Temperature Detectors are especially developed to meet the exacting demands of the atomic power industry. These detectors are now helping forestall costly fuel cell damage by providing near-instantaneous detection of a rise in temperature in light water moderators.

Super reliable and simple in design, Edison detectors eliminate complex electronic components. Some are rated at 0.8 seconds maximum response time and the high temperature types give an accuracy of $\pm 1.0\%$ at 750°C. Radiation- and corrosion-resistant, Edison detectors have quick disconnect features for reduction of installation and maintenance time.

Write for Bulletins 3016 and 3036 for information on types of Resistance Temperature Detectors and remote temperature monitoring systems for every purpose.

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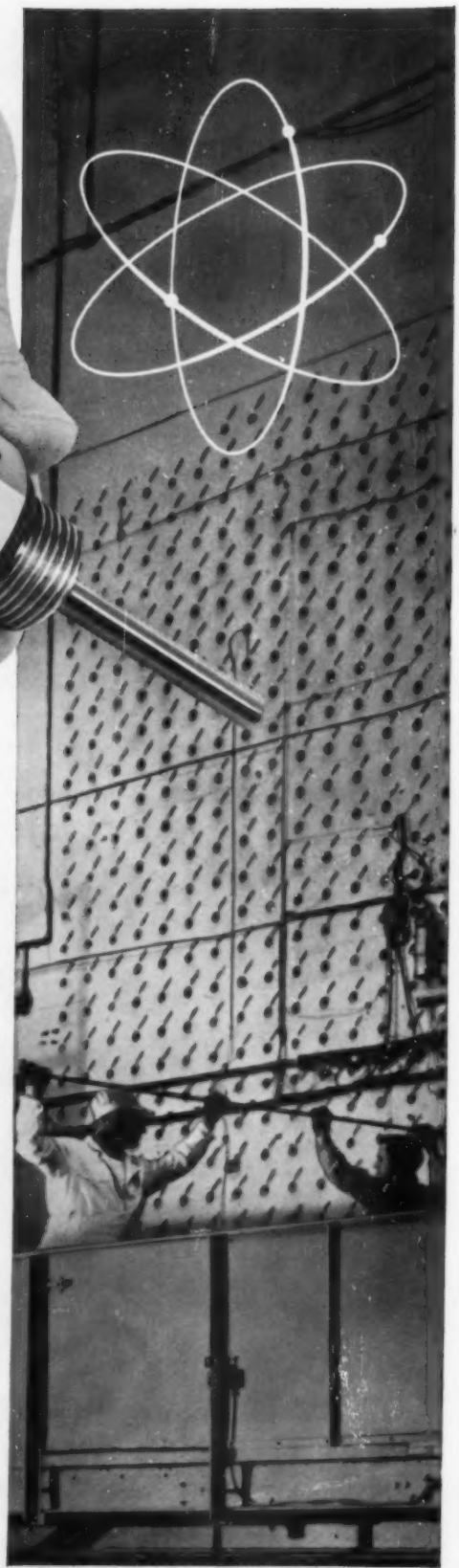

Photo courtesy of Union Carbide & Carbon Corporation

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PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS

ENGINEERS' PREVIEW

GENERAL ELECTRIC has received a contract to develop supersensitive instruments required to operate for many years without maintenance, for use on the U. S. Navy's atomic submarines.

Monitoring and controlling the coolant requires instrumentation with a reliability and sensitivity far above the level of today's conventional equipment. The service test models must function perfectly in conditions of high radiation for long periods without repair.

SIX SCIENTIFIC principles and six inventions that reshaped civilization are described in Science in Industry, a new 32-page booklet issued by the Du Pont Co.

The principles are Einstein's theory of relativity, Lavoisier's analysis of the composition of air, Newton's law of universal gravitation, Darwin's theory of evolution, Pasteur's theory of bacteria, and Copernicus' concept for the solar system.

The six inventions include: the airplane, the telephone, the steam engine, movable type, the automobile, and the clock with interchangeable parts.

DID YOU KNOW that there are salt mines under the Detroit, Michigan, area?

We didn't — and furthermore, during all the years in which we have been traveling to Detroit, calling on industrial power engineers and utility men there, not a soul ever mentioned to this writer that there were two important salt mines under the area. One of them is directly under Detroit, we understand, and the other under Windsor, Canada, just across the Detroit river. These are deposits of solid salt, we are told, as contrasted with the brine pools underlying much of Michigan north of there.

We were reminded of this when we recently had occasion to figure out a problem by the use of the graphical chart showing consumption of water softener regeneration salt, page 93, March 1956 issue. We were also reminded of it by the negotiations we are now carrying on for a second article on how to store and handle water softener salt most efficiently and economically, which we expect to have in a near future issue.

PUBLIC SERVICE Electric & Gas Company of New Jersey has ordered two 275,000-kw turbine generators, complete with associated power transformers, switchgear, controls, and power house auxiliary motors, from Westinghouse. This equipment will be installed in a new generating plant to be known as the Bergen Generating Station, located in Ridgefield, N. J. The large boiler feed pumps in the new units will be driven from the generator shafts — a new feature for units of this size.

S. MORGAN SMITH Company of York, Penna., will build three 280-in. Smith Kaplan turbines for a U. S. Army, Corps of Engineers project at Ice Harbor Lock and Dam on the Snake River, 12 miles from Pasco, Wash. The turbines will operate over a head range of 78 ft to 102.5 ft. Their rating is 143,000 hp at 90 rpm under 89 ft head. These will be the world's most powerful Kaplan turbines, surpassing even McNary, which has a rated capacity of 111,300 hp under 80 ft head.

REMEMBER the fine article Cost Estimating Must Be Done Right, by J. W. Hackney and W. E. Robertson of Diamond Alkali Co. in our November, 1955 issue? (Incidentally, we have distributed several thousand reprints of that article.)

Well, last June, Mr. Hackney delivered a paper along the same line, based on his POWER ENGINEERING article, before a group of cost engineers at the University of New Hampshire, Durham, New Hampshire.

Those engineers assembled to organize the American Association of Cost Engineers. Prime movers in

forming the Association were O. T. Zimmerman and Irvin Lavine of Industrial Research Service, Inc. They are establishing a new publication, *Cost Engineering*.

Attending the conference were cost engineers from all over the country to discuss their mutual problems of cost estimation, cost control and profitability. The group elected officers and drew up a constitution and by-laws. A board of directors and various committees are in operation and soon will be making plans for another annual meeting in 1957. Interested engineers who are qualified for membership should send an outline of education and experience to John T. Husted, Secretary, American Association of Cost Engineers, Box 1411, Trona, California. Dues are $10 a year.

CONSOLIDATED EDISON has awarded to Westinghouse a contract to design and construct the turbine-generator for its Indian Point nuclear electric station in Westchester County north of New York. The $8,000,000 machine will have a nameplate rating of 250,000 kw and will be designed for steam conditions of 335 psig and 1,000 F at the throttle, exhausting at 2-in. Hg. It is an 1,800-rpm, tandem-compound condensing unit; the turbine will have a double-flow high-pressure cylinder as well as a low-pressure element.

ATOMIC ENERGY Commission has approved construction of a prototype reactor plant to power a small submarine. The reactor will be built at the Nuclear Engineering and Development Laboratory being established near Windsor, Connecticut, by Combustion Engineering, Inc. Estimated cost of construction is about $10,000,000. Combustion Engineering is the third major AEC contractor to enter the naval reactor development program, the other two being Westinghouse Electric Corp. and General Electric Co.

DR. SEYMOUR BARON, with Burns and Roe, Inc. since 1950, has been promoted to technical director of the company's newly created Chemical and Nuclear Section. Recipient of a Ph.D. degree in Chemical Engineering from Columbia University, Dr. Baron is also a licensed professional engineer (New York State), and a member of ASME, AIChe, ANS (American Nuclear Society), and Sigma Xi.

"I've just finished this aptitude quiz, boss—Boy, am I fitted for your job!"

PERMISSION to use aluminum alloy 5086 for the fabrication of unfired pressure vessels has been granted by the American Society of Mechanical Engineers, says Kaiser Aluminum & Chemical Corp. The alloy, acceptable in both sheet and plate form under the ASME Code, is the highest strength aluminum alloy permitted thus far by the ASME for welded construction. It provides an 18-per-cent design advantage over the next highest-strength alloy.

Developed by Kaiser's Department of Metallurgical Research, non-heat-treatable 5086 is designed for welded structures requiring maximum joint strength and efficiency, plus light weight and corrosion resistance. It takes advantage of inert-gas, shielded-arc welding methods and provides excellent welding characteristics. Kaiser Aluminum recommends the use of Code-approved 5356 alloy wire or rod for filler material.

NEW YORK STATE Power Authority has awarded a $494,147 contract to ALCO Products, Inc. for fabrication of power dam components for the St. Lawrence River Power Project. Contract calls for 240 trash racks, suspension metal work for 34 diversion tunnel gates and a variety of steel stop logs and lifting beams for the Barnhart Island Power Plant, Long Sault Dam and the Massena Intake.

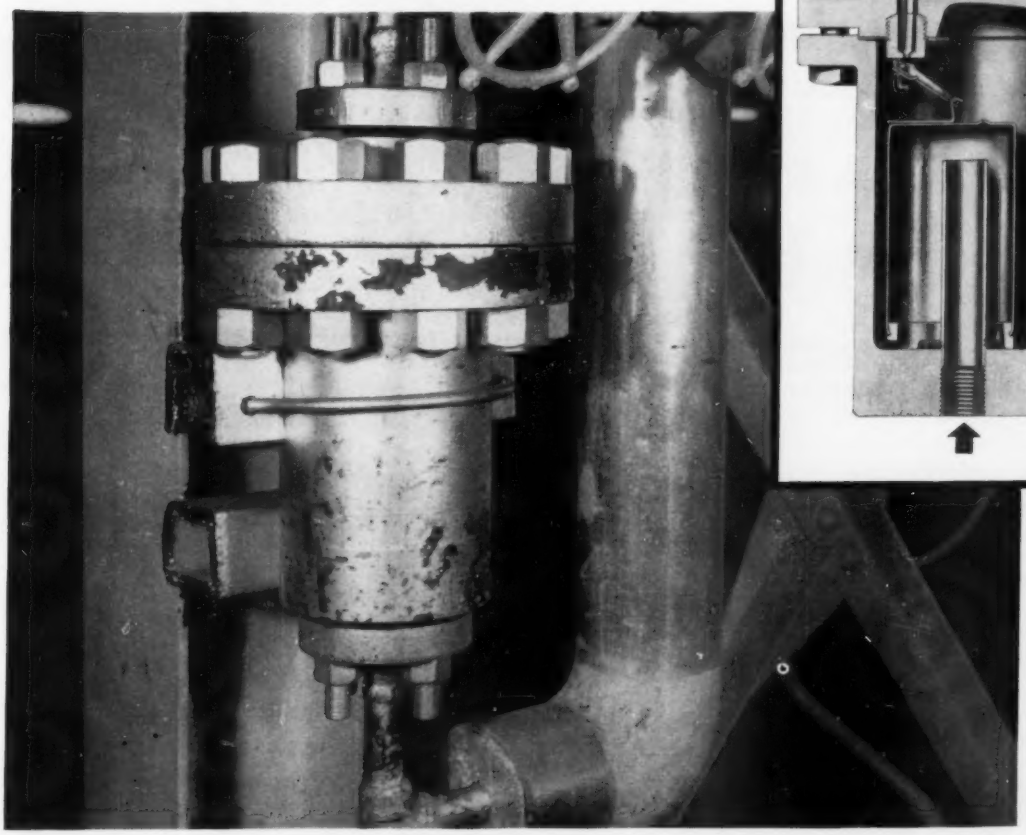
FLUOR CORPORATION, LTD. has been awarded a $7,500,000 contract to design and erect the second of four 60,000-kw steam electric generating units at the new San Bernardino steam plant of California Electric Power Co.

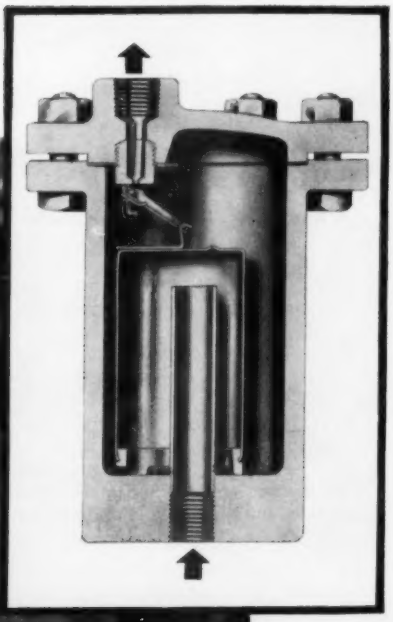
CLEVELAND Electric Illuminating Co. and The Diamond Alkali Co. have signed an electric-power purchase contract whereby The Illuminating Company agrees to furnish power to Diamond Alkali at its Painesville plant. With the continued growth in production, Diamond was faced with the decision of buying additional electric generating equipment to enlarge its own facilities or buying power from The Illuminating Company.

Because Diamond's business is the production of basic chemicals for industry and agriculture, the company elected to purchase additional power rather than to produce it. Diamond will operate its existing generating station while at the same time purchasing power from The Illuminating Company. It is expected that this arrangement will permit maximum power generating flexibility for continued growth of Diamond's Painesville plant.

SUBSTANTIAL reduction in the cost of manufacturing silicon solar cells, which promises to contribute greatly to finding increasing applications for solar energy, should be forthcoming in the near future, according to Dr. Morton B. Prince, director of research and development, Hoffman Semiconductor Division. He said that within two or three years the cost of converting solar energy into electricity by means of the silicon solar cells should be reduced from the $600 per watt present cost to about $30 per watt. He explained how present methods of solar energy conversion operate at approximately 10 percent efficiency. In two or three years this figure should increase to a point where we can capture some 15 percent of the sun's energy. However, he pointed out, loss factors which cannot be overcome limit the efficiency to about that amount. He also described several of the potential applications for solar energy converters.

ARMSTRONG FORGED STEEL STEAM TRAPS . . .





. . . the Best Answer to Superheated Steam Line Drainage, because:

LIST OF MATERIALS
ARMSTRONG FORGED STEEL TRAPS

Part	Material
CAP AND BODY FORGINGS	
Up to 600 psi, 750°	1030 carbon steel
Up to 900 psi, 900°	ASTM Spec. F-1 carbon moly steel
Up to 2500 psi, above 900°	ASTM Spec F-5 chrome moly steel
VALVE AND SEAT	Type 440 chrome steel, heat treated, standard. Stellite available.
LEVER MECHANISM	Stainless steel
BUCKET	Stainless steel
BOLTS	Class C high tensile, high temperature bolting material—125,000 min. tensile.
NUTS	Hex, semi-finish, heat treated for high pressure, high temperature service.
GASKET	Compressed graphited asbestos
INLET TUBE	Wrought iron

1. **Proved** in service in leading power plants throughout the world at pressures to 2400 psig.

2. **Experience** of Armstrong in design, manufacture and application dates back to the *beginning* of the trend to higher and higher pressures.

3. **Automatic** safety assured because of high capacity for warm-up loads; traps don't "forget" to drain the lines, and Armstrong traps *always* open for condensate.

4. **Economy** assured because of high value for price, long life with infrequent maintenance and freedom from steam loss.

5. **Quality** of workmanship and materials that is backed by a "complete satisfaction or your money back" guarantee.

SEND FOR THIS LITERATURE:

1. Should we trap superheated steam lines? — the answers of 11 engineers who have used traps for this service.

2. Catalog J — complete data on forged steel traps and steam trapping.

Application Engineered
STEAM TRAPS

ARMSTRONG MACHINE WORKS, 810 Maple Street, Three Rivers, Michigan

For more data circle 504 on Post Card

WHAT THEY TELL US

WHEN L. A. BORDER requested sample log sheets for a hospital boiler plant of two 250-hp boilers, various readers sent them on and we published one of the most appropriate in the July issue.

Here is another one sent in by R. D. Minehart, North Chicago, Ill. It has the advantage of showing everything on one side of the sheet. Space limitations allow us to show only the general arrangement, but you may get some ideas from it that can be adapted to your particular plant. (*See reproduction at bottom of page*).

CAMBRIDGE COBS ITS GENERATORS, the article in our May issue, page 59, prompted Reader T. C. B. of Ohio to write:

> Doesn't this method present an explosion hazard, because of the possibility of static electricity?
>
> I don't have any specific information on dust explosions in ground cobs. It just occurred to me that the possibility is there. Almost any organic material, and even many metals, if finely divided in suspension, can explode under the right conditions.
>
> Because we are all in the business of attempting to prevent accidents, I would be much interested in getting information on the point from POWER ENGINEERING'S readers.

We would, too. So far, after a number of inquiries, we have been unable to learn of any accidents resulting from the cobbing operation. Furthermore, a large power engineering organization here has just ordered the necessary equipment for cobbing its generators and motors and tells us it also thought of the hazard possibility. It investigated and could find no record of such explosion trouble.

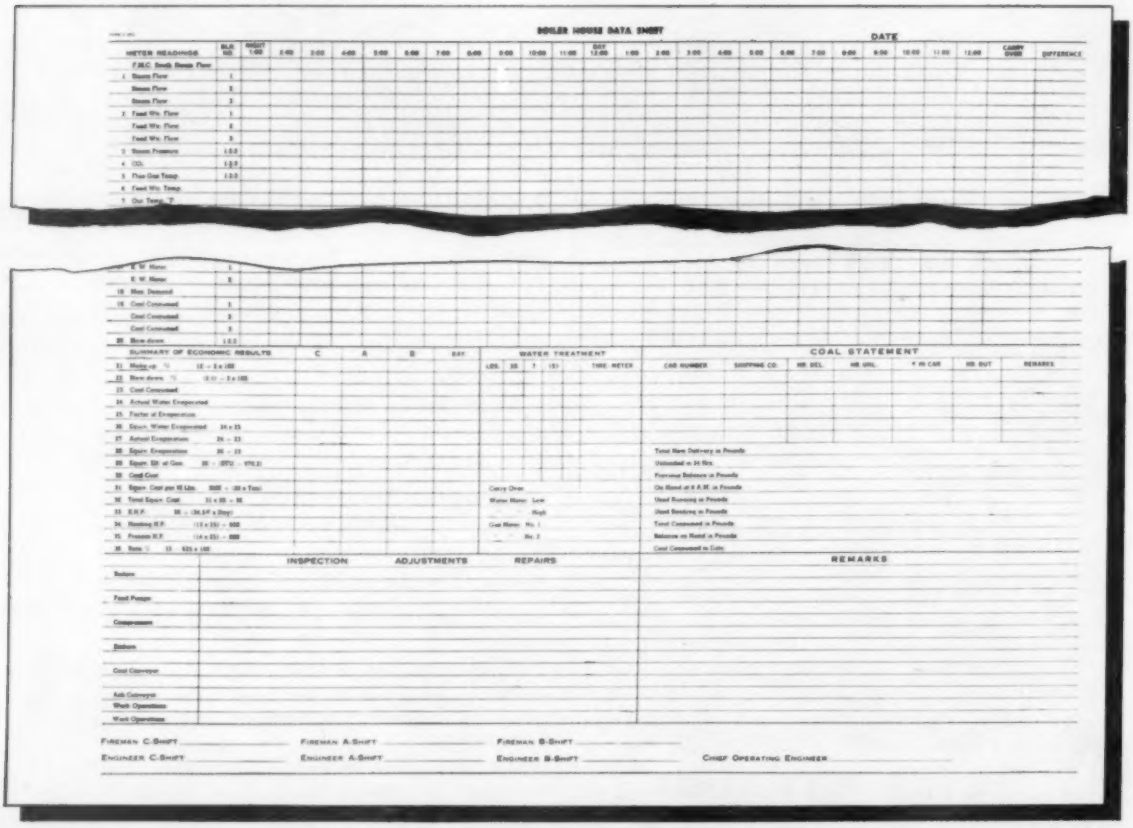
But perhaps we have all overlooked something and need a lot more information. Will readers who have had experience with the cobbing method tell us about this explosion possibility, so we can publish their comments for the benefit of all readers who may be interested? Write *What They Tell Us*, POWER ENGINEERING, 110 S. Dearborn St., Chicago 3, Ill.

SPEAKING OF OPERATIONS— hospital operations, that is — as C. T. Baker did in the August issue, page 75, we wonder how often hospital power engineers have come up against this problem, presented by Henry Sousa. He asks:

> Please send me information on sewer traps or ways of trapping plaster of paris in the cast room of a hospital, to prevent it from plugging up the drains and sewer lines.

Well, come on, you hospital engineers who have cast rooms in your hospitals. What do you do about this? Want to tell us, so we can tell Mr. Sousa, also publish your answers? Write *What They Tell Us.*

Drawing below refers to first item on this page



Log sheet for a 3-boiler coal-burning boiler house, including meter readings, coal data, water treatment, and inspection

Hall Industrial Water Report

VOLUME 4 OCTOBER 1956 NUMBER 5

Industrial Water, Pollution of Streams, Water Shortages—These are Serious Problems Confronting Industrial Areas Everywhere

Treating water for re-use, eliminating contaminants from streams, and engineering water in short supply are functions of chemical engineers skilled in water technology. Hall Laboratories is providing these services for industry at home and abroad.

England Was Not Merry England

Things were not so jolly for a large English factory when plans for expansion ran head-on into the fact that not enough suitable water was available for an enlarged power plant and increased process facilities.

The plant had two main water supplies. First-quality water from the city mains was limited in amount because of existing industrial and residential needs. The other supply was contaminated with sea water, decayed vegetation, sewage and synthetic detergents.

Hall Laboratories was engaged to conduct a plant-wide survey to assess all uses of water in the plant and to recommend means for reducing water consumption, improving and extending the use of the inferior quality water, and making condensate, treated and untreated water available for re-use. The primary concerns of Hall staff engineers H. A. Reda and Leonard Highley, Jr., were to limit use of the first-quality water so as to release a sufficient amount for the new high-pressure boilers, and to develop a better grade of process water.

The plant was using two million gallons of first-quality water and two million gallons of process water per day. Working from point to point through the plant with the cooperation of the plant staff, Highley and Reda were able to recommend a number of water saving changes. For example, about 150 drinking fountains were allowed to run constantly to keep the water cool. All this waste could be avoided with automatic coolers. Furthermore, it was concluded that city water was not required for cooling and process work and that an acceptable grade of process water, better than the second existing supply, could be provided by treatment of the effluent from a neighboring sewage disposal plant. Using this same treated water the plant could install a number of closed cooling systems, reducing requirements for cooling water by 90 percent.

Reda and Highley estimated that the conservation program will reduce the daily requirements for city water and for the new process water to one million gallons of each per day. The plant can now proceed with its plans for expansion. In addition, it is expected that the savings in water costs will pay off the investment for the changes in 4 to 5 years.

Water Tax Increased By Contaminated Effluent

When a steel products manufacturing plant near Cincinnati, Ohio, received a water tax bill more than 12 times the usual amount, they learned to their chagrin that their plant was contaminating an adjacent creek as well as discharging contaminated water to the city sanitary sewage system.

Work was started at once to eliminate the pollution. Some effective inplant changes were made, but these were not enough, since a subsequent analysis of the plant's effluent by the authorities revealed more suspended solids than tolerable in the cooling water being discharged to the creek.

A factual survey by J. H. Covode of Hall's Cincinnati office and H. A. Reda of the Pittsburgh staff established that suspended solids in the water from the plant's once-through cooling system were the only objectionable contaminant. As a result, part of these solids, originating from the dust collectors, were diverted temporarily to the municipal sanitary sewage system. When Reda and Covode pointed out that the water from the dust collectors could be clarified, studies were undertaken to compare the cost of doing this with the saving that would be realized from reduction of taxes for discharge of unpolluted water to the city sewage system.

Further study revealed that approximately 50 percent of the suspended solids carried by the cooling water came from precipitation of dissolved iron originating in the plant well water. Less but significant contamination occurred in the following ways. At the end of a melt, when the furnaces were tilted, cooling water was discharged directly to the dust-laden floor and into the open floor drains. This water then flowed into an open ditch located alongside the building. Roof drains also discharged into this ditch. The water then ran under a railroad culvert where dirt was shaken into it when trains passed overhead.

After plant management had put into effect all corrective changes, the authorities were satisfied and the tax was dropped to the normal rate for unpolluted water with a saving of more than $6000 per year.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information write, wire or call Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

Water is your industry's most important raw material. Use it wisely.

Hall Laboratories, Inc.—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

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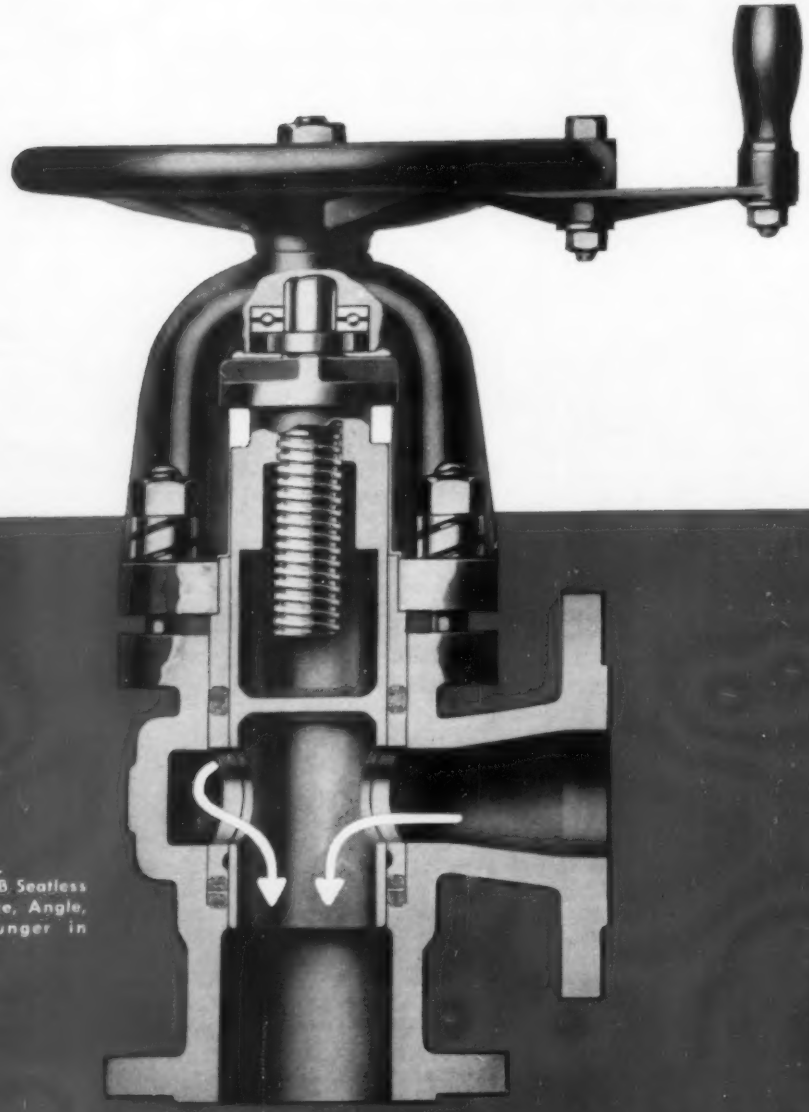


Yarway Type B Seatless Blow-Off Valve, Angle, showing plunger in open position.

YARWAY

trouble-free blow-down service

YARWAY SEATLESS BLOW-OFF VALVES

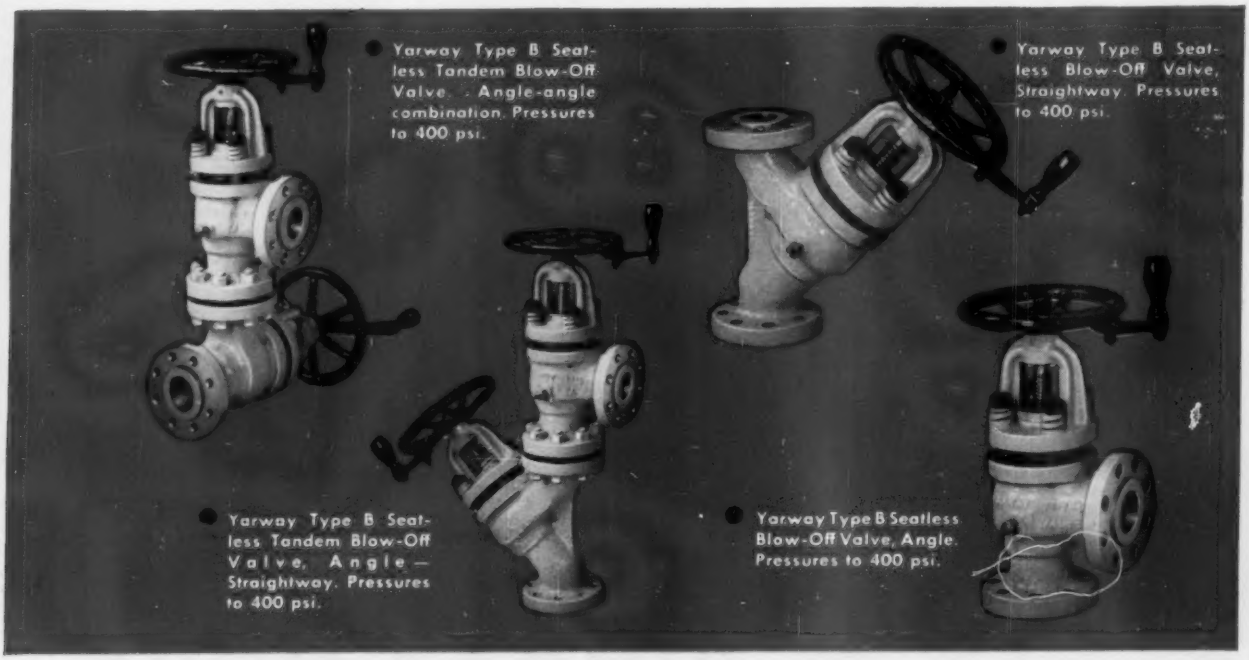
"Trouble preventers" is what YARWAY Seatless Blow-Off Valves are often called because they eliminate one of the commonest sources of trouble in low and medium pressure boiler blow-down service. *There is NO SEAT to score, wear, clog or leak.*

YARWAY Seatless Blow-Off Valves feature a balanced, sliding, hollow plunger design that permits free and easy operation—full, unobstructed flow.

More than 16,000 boiler plants today use YARWAY *Blow-Off Valves.*

YARWAY Bulletin B-426 shows all the latest types and features of YARWAY Seatless Blow-Off Valves. If you operate your boilers up to 400 psi, you'll find a copy helpful. For higher pressures, ask for Bulletin B-434. Write today.

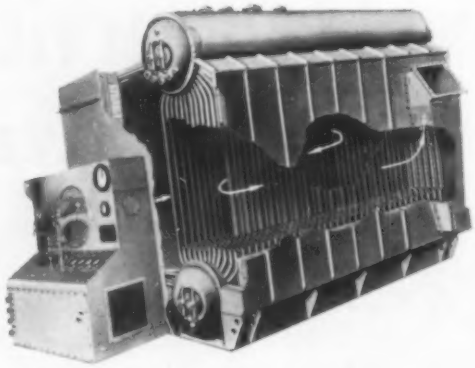
YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES


Yarway Type B Seatless Tandem Blow-Off Valve. Angle-angle combination. Pressures to 400 psi.
Yarway Type B Seatless Blow-Off Valve, Straightway. Pressures to 400 psi.
Yarway Type B Seatless Tandem Blow-Off Valve, Angle—Straightway. Pressures to 400 psi.
Yarway Type B Seatless Blow-Off Valve, Angle. Pressures to 400 psi.

— blow-off valves

For more data circle 506 on Post Card

MODERN OIL AND

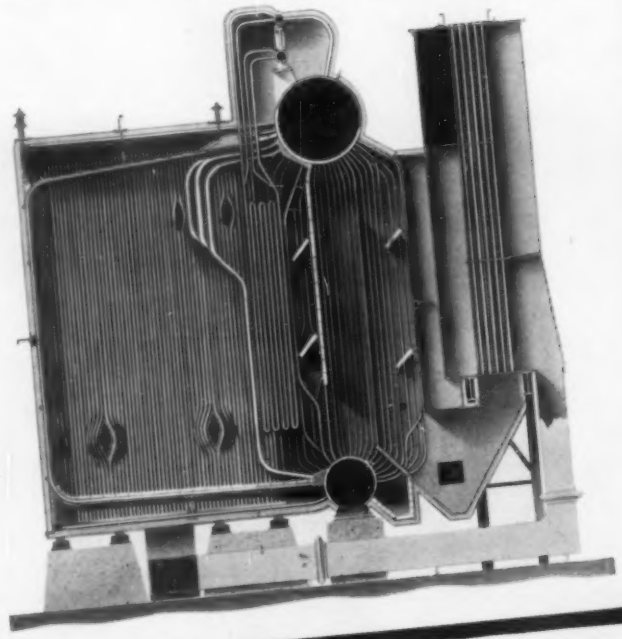


C-E Package Boiler—Type VP

Completely shop assembled . . . available in fourteen sizes from 4,000 to 40,000 lb capacity . . . pressures to 500 psi. Available with integral console control panel, this unit contains more water-cooled area per cubic foot of furnace volume than any other boiler of its size and type. It can be equipped with any of several approved burners.

C-E Vertical Unit Boiler —Type VU-55

Available in six sizes . . . capacities from 50,000 to 120,000 lb steam per hour . . . designed for two pressure ranges, 250 psi and 500 psi, and total steam temperatures up to 750 F. This double cased, gas-tight unit is equipped with tangential burners. A large (60-inch) steam drum assures generous water capacity and steam reservoir space. Tangent tube waterwalls offer complete furnace protection, minimizing maintenance.



COMBUSTION

Combustion Engineering Building

STEAM GENERATING UNITS • NUCLEAR REACTORS • PAPER MILL EQUIPMENT • PULVERIZERS • FLASH DRYING

GAS FIRED BOILERS

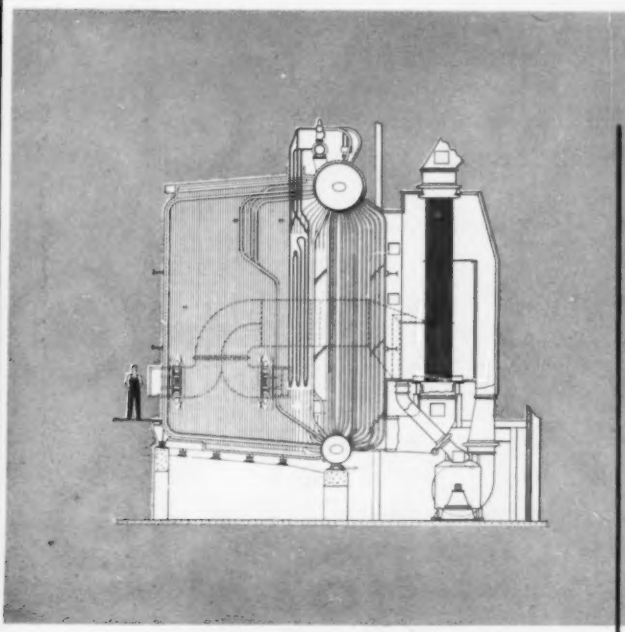
The boilers illustrated here cover the broad capacity range from 4,000 to 600,000 lb of steam per hr. They are all especially designed for gas and/or oil firing. The two units shown on the left page (Types VP and VU-55) are standardized and each is available in several sizes. The capacity range covered by these two units is from 4,000 to 120,000 lb per hr. The two units below are custom designed for various capacity, pressure and temperature requirements up to 600,000 lb per hr 1400 psi and 950 F. All these units are pressure fired and do not require induced draft fans.

Collectively, they offer an exceptional diversity of choice. A brief consideration of the features of each type will help you "pinpoint" the design characteristics best suited to your particular needs.

Of course there are other C-E two drum Vertical-Unit Boilers available for pressures up to 1400 psi and temperatures up to 960 F. Shown here are but four popular members of the C-E family of Vertical-Unit Boilers—a family which has achieved a wide measure of acceptance using all types of fuel.

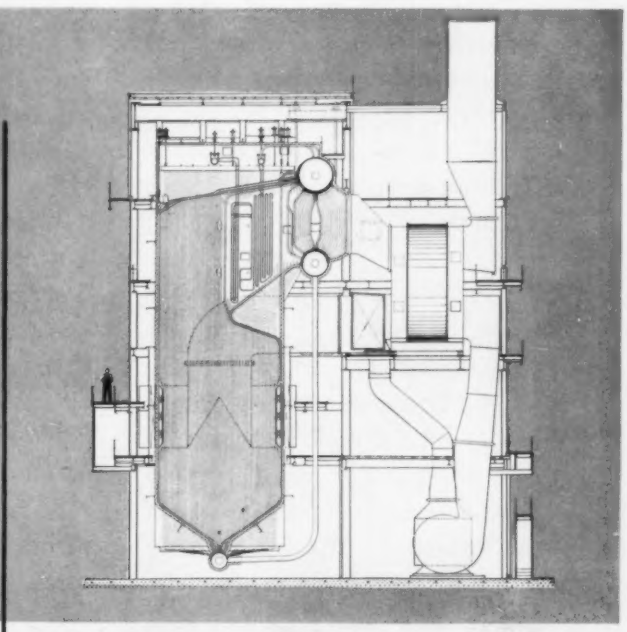
Please feel free to call on us for further detailed information. Catalogs are available upon request.

B-922



C-E Vertical Unit Boiler—Type VU-50B

This unit is available for capacities from 50,000 to 400,000 lb per hr—pressures to 1400 psi and temperatures to 950 F. This bottom-supported design uses tilting tangential burners providing effective superheat control. Horizontal burners can be furnished if desired. Heat recovery equipment as required. This unit makes available to industrial installations a standard of performance comparable to utility practice.



C-E Vertical Unit Boiler—Type V2

This unit is available for capacities from 200,000 to 600,000 lb per hr. It can be designed for pressures up to 1400 psi and for temperatures to 950 F. Tilting tangential burners, providing superheat control, are standard equipment although horizontal burners are available, if desired. A double, gas-tight casing assures lifetime tightness and minimum heat loss. Heat recovery equipment can be furnished as desired.

ENGINEERING

200 Madison Avenue, New York 16, N. Y.

SYSTEMS • PRESSURE VESSELS • HOME HEATING AND COOLING UNITS • DOMESTIC WATER HEATERS • SOIL PIPE

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"We had as many as 24 Solenoid coils a month burn up before we installed BUSS FUSTATS" . . .

"Now our burned up coil losses are negligible."

C. R. Babcock. CHIEF ELECTRICIAN
DEWEY PORTLAND CEMENT CO., DAVENPORT, IOWA

Mr. Babcock continues ——

"The burning up of the solenoid coils that activate the plungers that dump our weighing scales was a real problem with us. We lost as many as 4 coils on one 8 hr. shift. The maximum was about 24 coils a month.

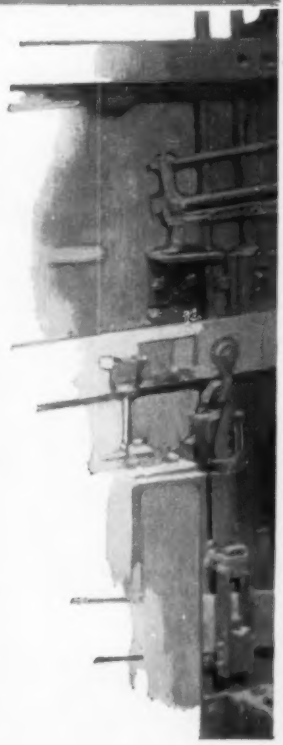
"Trouble develops on the days when the gypsum for our cement picks up moisture and sticks to the scales. Then the counterbalance can't reset the scale and, as a result, the plunger moves up and down energizing and de-energizing the thrust coil. The coil has only a few turns of large copper wire and draws a heavy current each time it is energized. It heats up quickly and burns up.

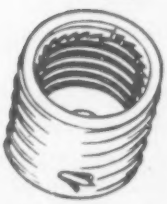
"To give over-load protection to the thrust coil, which is on a 125 volt DC power supply, we installed a 3.2 BUSS Fustat in a series with the coil. (BUSS Fustats are FUSETRON dual-element fuses with a type S base for use on circuits up to 125 volts.)

"Now, when there is trouble the Fustat opens before the coil is damaged. The scale is cleaned and another Fustat installed. We are then back in operation.

"We have three of these scales and at the present time we are replacing only about one coil a month and this is generally due to mechanical and moisture damage.

"We figure BUSS Fustats save us money in two ways — by practically eliminating the cost of replacing solenoid coils — and by greatly reducing our down-time losses."





On circuits of 125 volts or less —

The Proper Size BUSS Fustat can Reduce Danger of Burnout of Solenoids, Coils, Transformers and Motors

A BUSS Fustat is a Fusetron dual-element fuse with a type S base for use on circuits of 125 volts or less. A Fustat gives all the protection of a fuse against short-circuits or dangerous overloads — yet, it permits circuit to be loaded safely to maximum capacity.

Protecting Solenoids, Coils and Transformers —

By installing the proper size Fustat, a solenoid can be protected because the Fustat will not open on the operating surge but will open in time to protect, should the heavy current continue too long for any reason.

A transformer or coil, likewise, can be protected because the long time-lag of the Fustat permits it to hold all normal current surges and harmless overloads — yet it will open to prevent burnout on any dangerous overloads.

Protecting Motors against burnouts —

A BUSS Fustat of motor-running protection size mounted anywhere in the circuit to handle ONLY the motor current will give finest available protection against burnout of the motor.

Nothing else is needed. Underwriters' Laboratories listing gives Fustats same degree of approval for both motor-running and short-circuit protection as the most expensive devices made.

BUSS Fustats stop dangerous practice of tampering or overfuseing

The type S (tampering resisting) base of a Fustat prevents anyone replacing them with an ordinary fuse, a penny or other substitute — or with a size too large to protect.

Fustats fit ordinary Edison base fuse holders through use on an inexpensive adapter that once installed need never be replaced.

Write for bulletin SMPS.

On any circuit up to 600 volts — Use a FUSETRON dual-element Fuse.

Fusetron fuses protect motors, solenoids, coils and transformers against burnout; they offer maximum safety because of their 100,000 amp. interrupting rating; they help increase production by eliminating needless blows and they cut maintenance costs because they are maintenance free.

Write for bulletin FIS . . .

For loads above 600 and up to 5,000 amps. — Use BUSS Hi-Cap Fuses.

When coordinated with Fusetron fuses they will not open ahead of the fuse nearest fault . . .

Write for bulletin HCS.

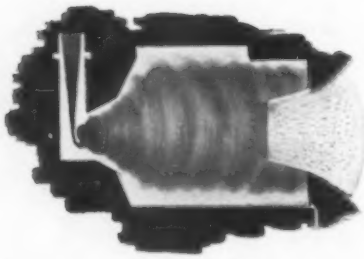
Play Safe! **Install BUSS Fustats, FUSETRON Fuses and BUSS Hi-Cap Fuses throughout entire Electrical System!**

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

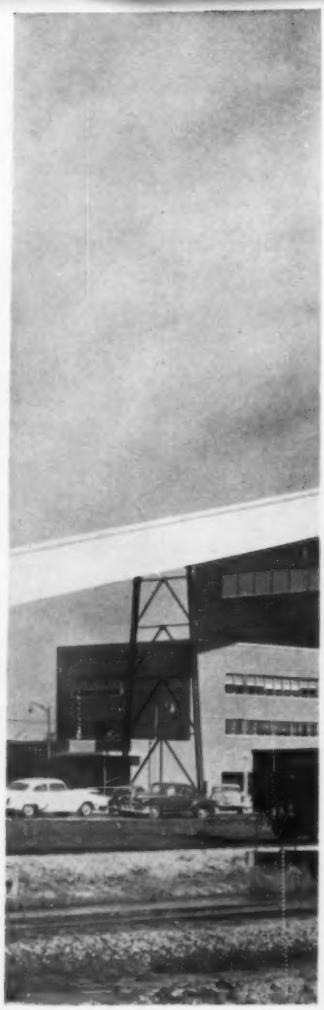
956

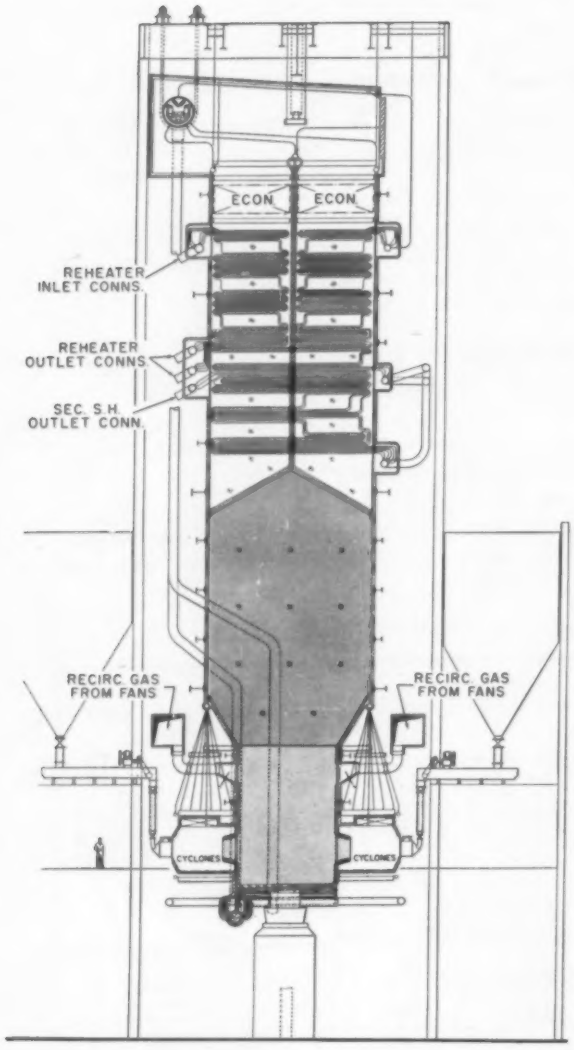
Bussmann Mfg. Co. (*Division of McGraw Electric Co.*)
University at Jefferson, St. Louis 7, Mo.

For more data circle 508 on Post Card



CYCLONE FURNACE FOR ST. CLAIR



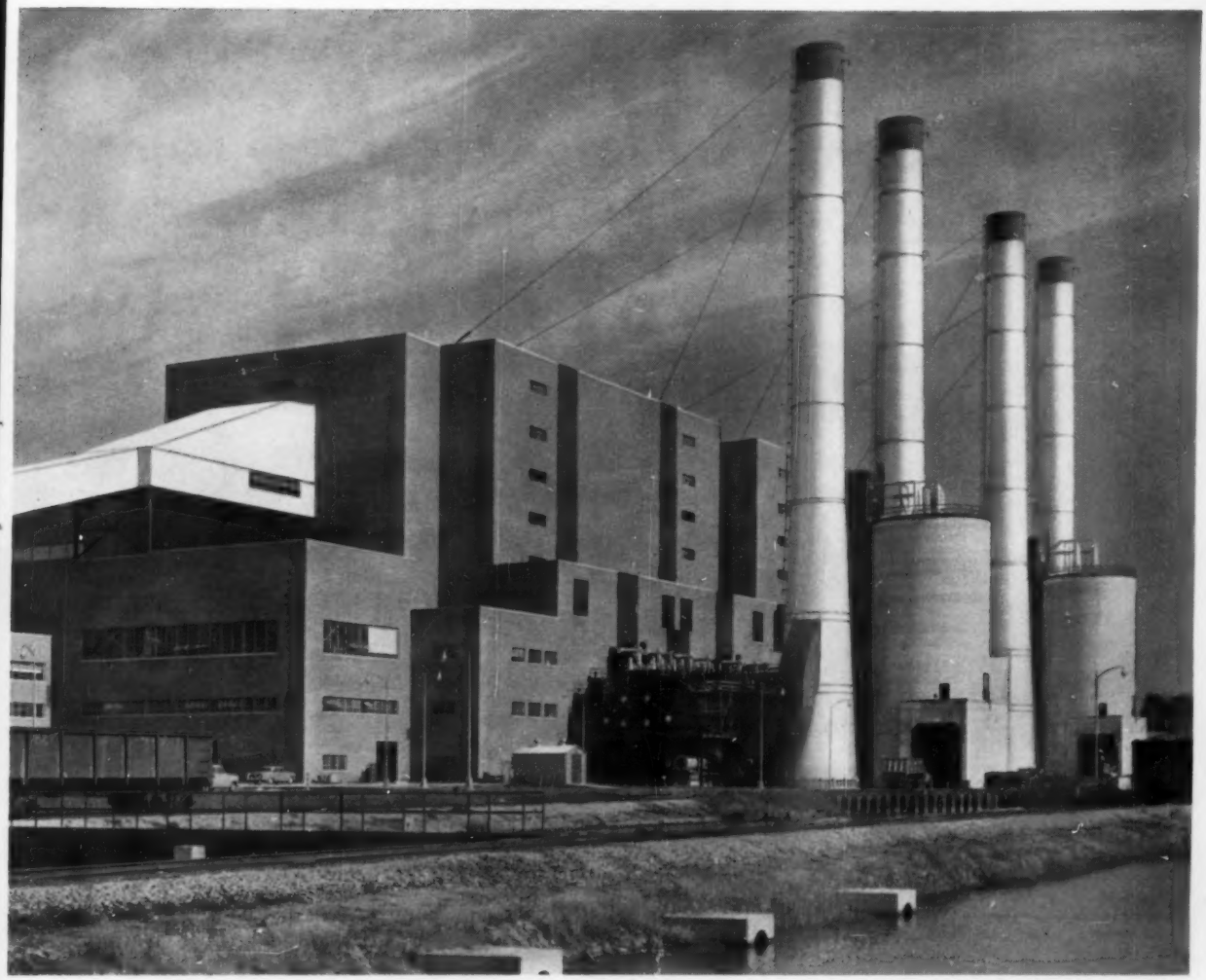


Detroit Edison Company's pioneering of more efficient power generation with better boilers, larger turbines and technical improvements of many kinds takes another step forward with the selection of a Cyclone Furnace-fired B&W Radiant Reheat Boiler for St. Clair Station.

The new generating unit will provide guaranteed capability of 325,000 kw, and the boiler will deliver 2,100,000 lb of steam per hr at 2450 psi and 1050 F at the superheater outlet. Reheat temperature is 1000 F.

ELIMINATION OF HEAVY FLY-ASH DISCHARGE WITH CYCLONE FURNACES

Cyclone Furnace Boilers offer many advantages. One important feature is the elimination of heavy fly-ash discharge from the stack. Most of the ash from the burning coal is melted into easy-to-handle slag right in the Cyclone Furnace. This ash never gets into the gas stream, with the result that dust loading is reduced to very small amounts.



St. Clair Station of Detroit Edison Company. Four B&W units are presently in operation, and a fifth unit—Cyclone Furnace-fired—is now on order.

The Cyclone Furnace offers many other benefits. Through simplification of the entire process of coal preparation, combustion, ash segregation, and ash handling, it makes possible economies in inital cost, operating labor and fuel consumption. Maintenance costs are cut because so much maintenance-causing machinery is eliminated. These are some of the reasons why fifty-six boilers of all sizes are now in operation or on order with a total of over 130 Cyclone Furnaces.

CLEAN STEAM WITH CYCLONE SEPARATORS

Adequate circulation of water throughout the boiler —even at the high design pressure of 2700 psi for the St. Clair unit—is assured with safety by B&W's efficient Cyclone Steam Separators. Located inside the drum, these simple, stationary devices require no power, need no maintenance, do not take up building room. In conjunction with Steam Scrubbers, the Cyclone Separators make it possible to send steam of highest purity to the turbine, contributing to greater turbine efficiency and decreasing the amount of turbine cleaning required.

* * *

These and many other modern advances in combustion and high-pressure, high-temperature steam generation are available to you. We will be glad to discuss them with you in connection with your future plans. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

G-794

BABCOCK & WILCOX

BOILER DIVISION

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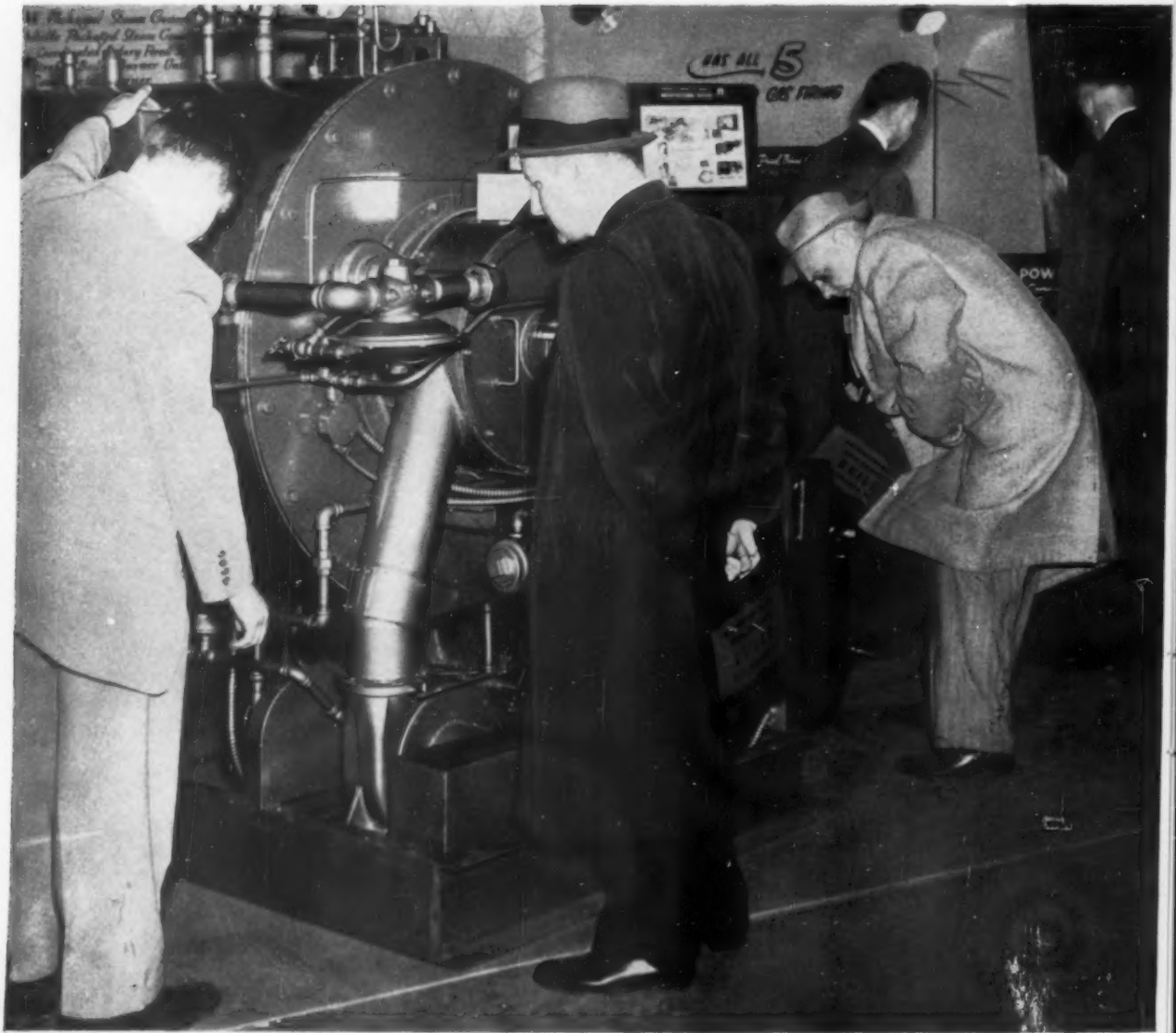

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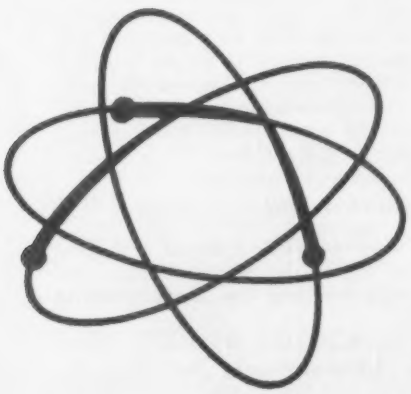

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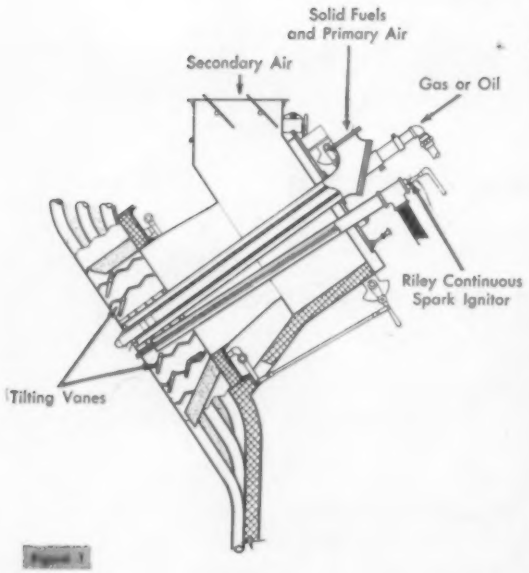
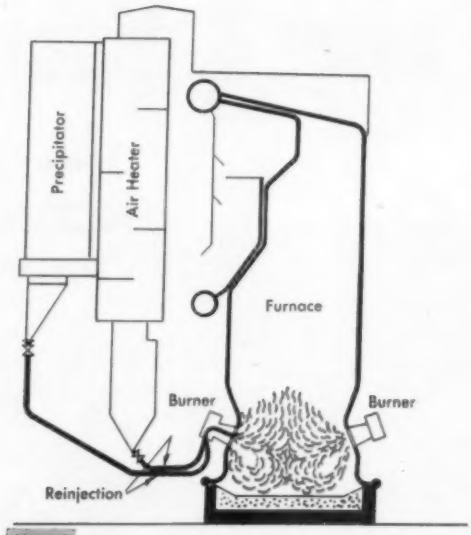
COMPANY'S BUSINESS, SERVICE OR PRODUCT_____

3805

why the Riley TURBO

. . . why it eliminates flyash disposal
. . . why practically any available fuel
. . . why higher operating economies





In 1952 a well known eastern chemical company had costly flyash disposal problems at two of its plants. At the time Riley Stoker Corporation had been developing a new type of slag tap furnace design to permit refiring flyash and disposing of it as slag. The idea was accepted. Two Riley boilers with the new furnace were installed . . . one to refire its own flyash, the other to refire its own and that of an adjacent conventional dry bottom unit.

The success of these boilers in eliminating the problem of flyash disposal is a matter of record . . . but the real success story lies in the other outstanding operating characteristics of this type of boiler unit, operating characteristics long sought by engineers and designers.

METHOD OF FIRING

Riley directional flame burners (Fig. 1) inclined slightly downward and located opposite each other in opposite furnace walls (Fig. 2) produce an extremely hot turbulent flame in a restricted, concentrated combustion zone just above the slag pool. Temperatures are high enough to maintain a fluid slag pool even at low loads.

MINIMUM CARBON LOSS

When flyash is refired in the combustion zone practically all the carbon in the ash is burned with residue turning to molten slag. Unburned losses are infinitesimal even in small boilers. Efficiencies of 90% and over are attained and sustained.

LOW FURNACE EXIT GAS TEMPERATURE

A "top secret" of the Riley *Turbo Furnace* is low furnace exit gas temperature produced by bottom-of-furnace firing. Temperature curves in Fig. 3 show *Turbo Furnace* exit gas temperatures at 100 F. to 220 F. below those of a conventional dry bottom unit operating at the same load, having the same capacity and the same amount of water cooling.

FURNACE EXIT TEMPERATURES THE SAME WITH ANY FUEL

The curves in Fig. 3 also indicate that in the *Turbo Furnace* the exit gas temperatures of a variety of fuels are approximately the same. For example, when burning natural gas the furnace bottom contour produces a luminous flame similar in size and appearance to coal flame; result: almost identical furnace exit temperatures.

USES A MULTIPLICITY OF FUELS

Because exit gas temperatures are so nearly identical with any fuel, the *Turbo Furnace* is uniquely suited for high steam temperature installations where uniform steam temperature is wanted while burning coal, lignite, gas, oil, fluid coke, or a combination of these fuels.

NO SOOT AND SLAG BLOWERS NEEDED

With retention of the major portion of ash in the furnace bottom and with resulting low temperatures in

An Advertisement Prepared By

Riley designs, manufactures and erects steam generating units complete with

Worcester New York Philadelphia Buffalo Pittsburgh Cleveland Detroit Chicago Cincinnati Charlotte New Orleans

FURNACE is so versatile

and does away with slag blowers
can be burned in it at any time
are attained and sustained

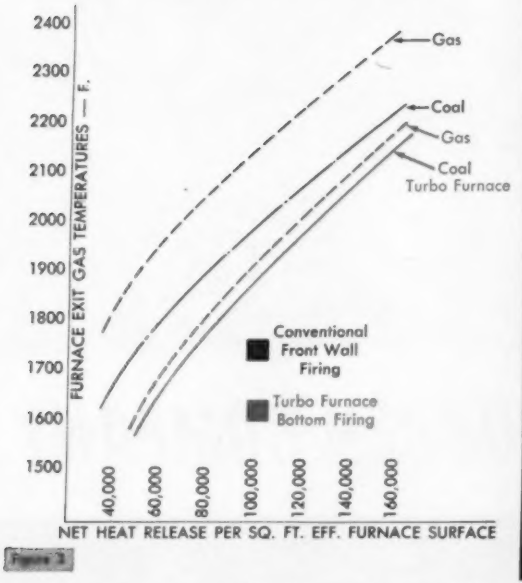


Figure 3

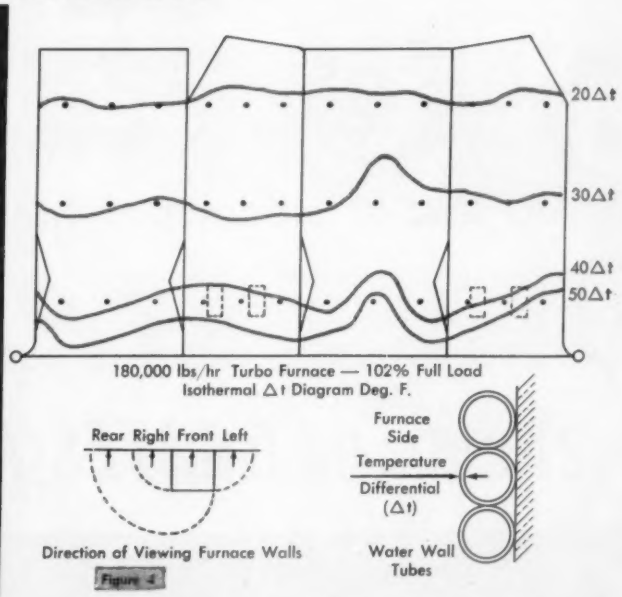


Figure 4

the upper part of the furnace no slagging occurs even with ash of lowest fusion temperatures. Since combustion is restricted to furnace bottom there is no impingement of flame on furnace wall tubes. Only a light dust coating on furnace walls and on convection tube bank occurs. (Fig. 4) illustrates the effect of the cleanliness of the *Turbo Furnace* . . . relatively flat isothermal lines obtained in tests on one of the chemical company's units from readings of centerline thermocouples.

SIMPLIFIED DESIGN AND CONTROL OF SUPERHEATER AND REHEATER

With heat distributed evenly within the furnace and constant temperatures maintained regardless of fuels used the design and control of superheater and reheater for the *Turbo Furnace* unit is greatly simplified.

OPERATION POSSIBLE EVEN WHILE CHANGING TO SOLID FUEL

With pressure parts constant for all fuels a *Turbo Furnace* installed initially to fire gas or oil and designed with a furnace heat release compatible with coal firing can "stay on the line" during installation and hook up of solid fuel handling equipment. No ash hopper has to be added, and Riley directional flame burners are already equipped with coal heads for quick connection to pulverizers.

HIGHER HEAT RELEASES SMALLER SETTINGS

With lower exit gas temperatures the *Turbo Furnace* can be designed for higher heat release rates of both furnace envelope and furnace volume. A smaller furnace without a hopper bottom results in lower overall height.

ONE LEVEL BURNER OPERATION

Burner operation at or near the turbine level has long been desired. The Riley *Turbo Furnace* with all its burners on one level near the bottom of the unit makes one level operation a practical reality.

VERSATILE OPERATING FEATURES REFLECTED IN RECENT PURCHASES

An eastern seaboard public utility will operate three 500,000 lb. per hour *Turbo Furnace* units designed specifically to burn fluid coke plus oil, gas, coal. A Louisiana public utility has ordered a 1,550,000 lb. per hour reheat unit to fire natural gas, but for future conversion to solid fuels. Three 320,000 lb. per hour *Turbo Furnace* units will be installed by a prominent aluminum producer for gas, oil and future pulverized coal. A Texas public utility has purchased an 825,000 lb. per hour reheat unit for natural gas and future pulverized coal or lignite. Another Texas public utility has ordered a 1,260,000 lb. per hour reheat unit for gas firing and future pulverized lignite.

Such acceptance of a relatively new design is recognition of the sound operating advantages involved.

RILEY STOKER CORPORATION *of Worcester, Massachusetts*

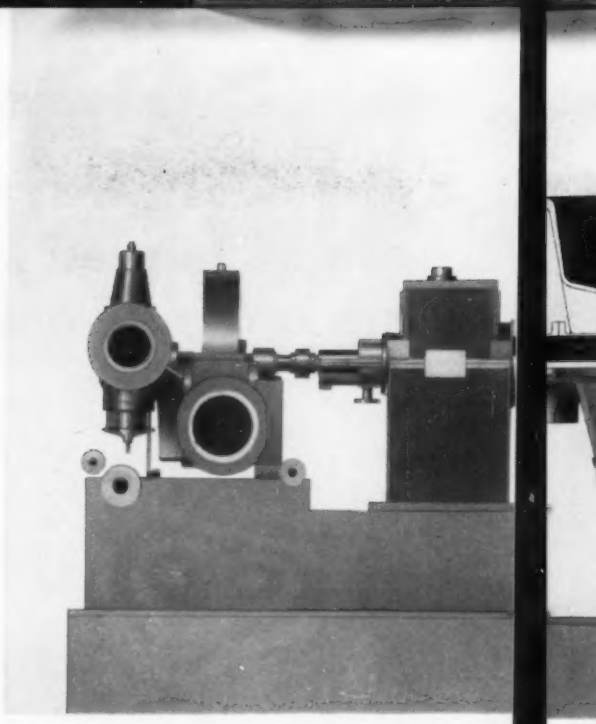
heat recovery equipment and fuel burning equipment for all industries and public utilities.

Atlanta St. Louis Kansas City St. Paul Houston Denver (Englewood) Salt Lake City Los Angeles San Francisco Portland Seattle

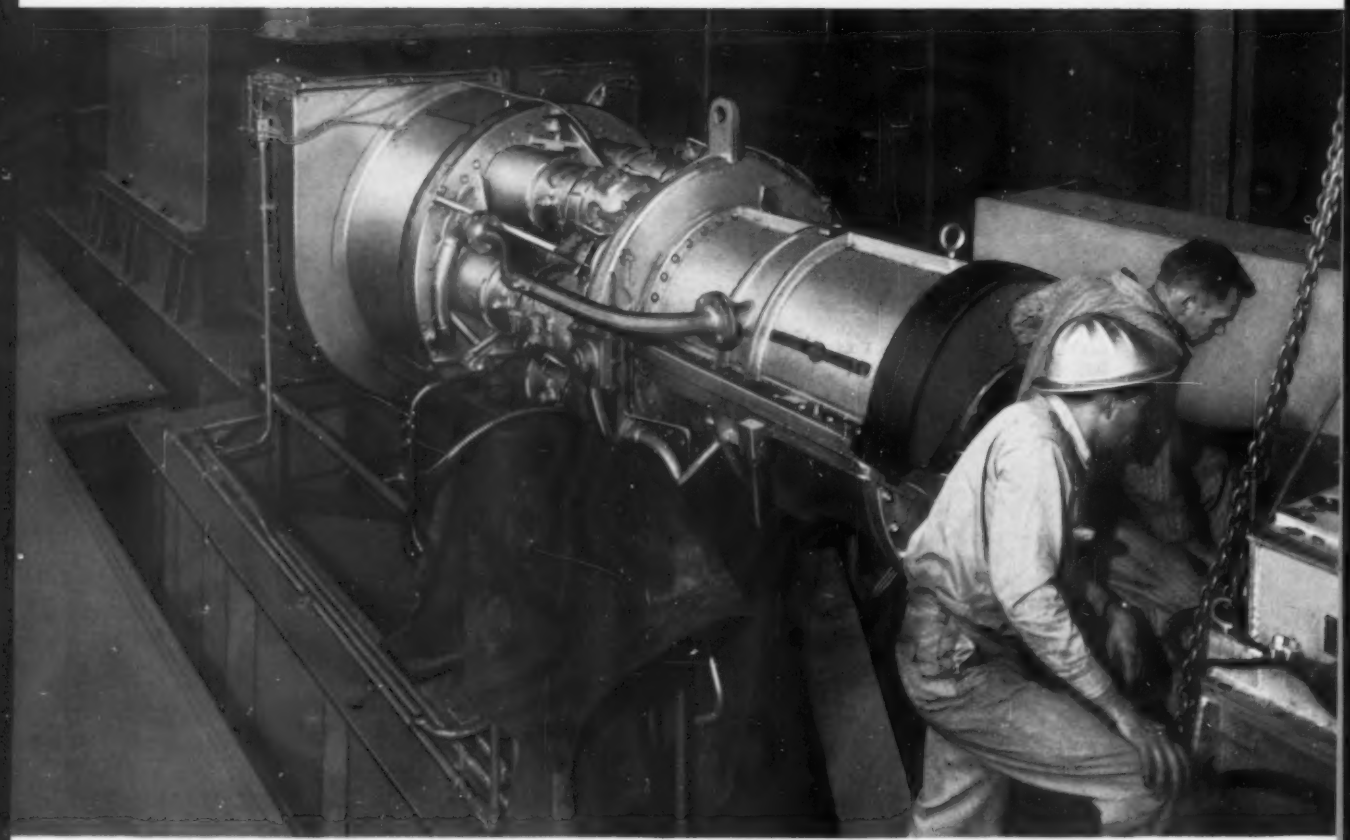
For more data circle 511 on Post Card

GAS TURBINES

Rubber industry's first gas turbine is used with supplementary-fired heat recovery boiler to generate 120,000 lbs. of steam per hour

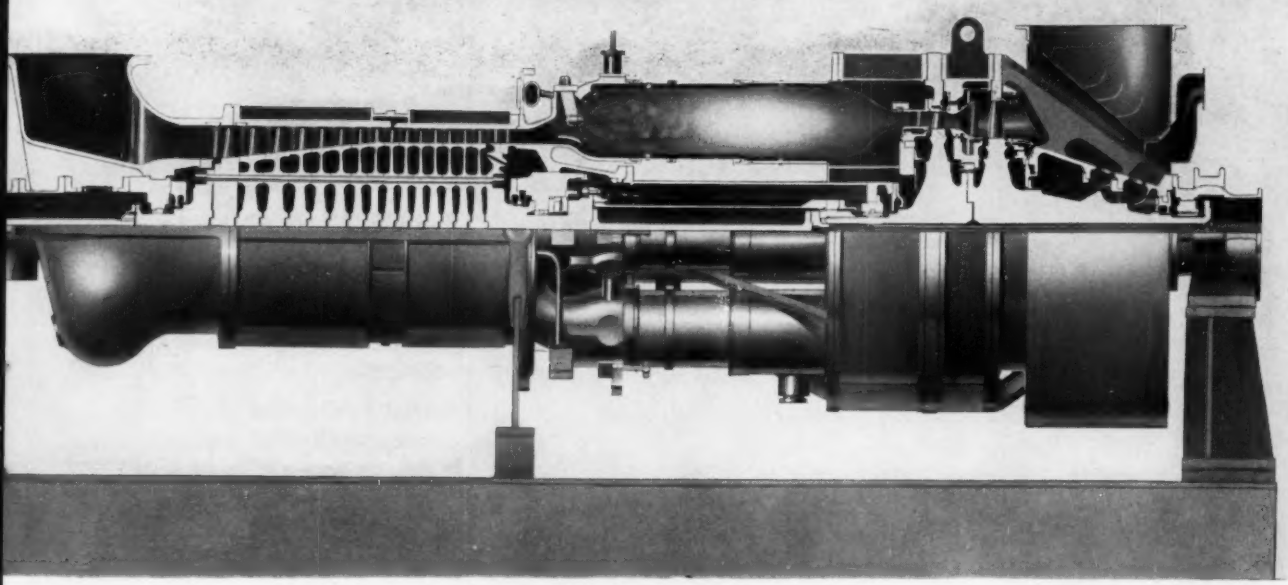


AT GATES RUBBER COMPANY..



GENERAL ELECTRIC 5000-KW GAS TURBINE being installed at Gates Rubber Company in Denver, Colorado. Compact design requires minimum space and minimum expense for foundat'on. With simple basic construction and few wearing parts, unit requires little maintenance and few operating personnel.

The General Electric 5000-kw simple-cycle, single-shaft gas turbine at 60 F ambient supplies 310,000 pounds of 828 F exhaust gas per hour to boiler.



..General Electric gas turbine meets need for process steam, more power

To meet the needs of increased production at Gates Rubber Company, additional steam generating capacity as well as more electric power was required. This progressive company investigated many possible cycle arrangements. It was found that their requirements could be met most economically by a General Electric 5000-kw gas turbine-generator with a heat recovery boiler arranged for supplementary firing to produce 120,000 lbs. of steam per hour.

The hot, gas turbine exhaust, which contains approximately 80% of its original oxygen, is used to generate part of the steam load and to provide highly preheated boiler combustion air for supplementary firing. Over-all efficiency of the cycle is approximately 70% and, since boiler capacity and pressure may be varied without affecting turbine and generator performance, the application provides wide flexibility in meeting process steam needs.

This is the rubber industry's first installation of a gas turbine with heat recovery boiler used to produce steam for process. It is a further example of how the versatility of the General Electric gas turbine is being put to work in solving the special problems of process industries. And performance of G-E gas turbines has been proved by over 100 units now installed, aggregating 147 turbine-years of operation.

Whether your plant needs shaft power, compressed air, large quantities of hot gas, or a combination of these, it's possible that a General Electric gas turbine can meet your requirements with maximum savings in investment and in operating and maintenance costs. Why not ask your G-E Apparatus Sales Representative to explore these possibilities with your engineers. Or write for further information to General Electric Company, Section 261-24, Schenectady 5, New York.

Progress Is Our Most Important Product

GENERAL ELECTRIC

For more data circle 512 on Post Card

ERIE CITY STEAM GENERATORS at ONE for all MAJOR COMPONENTS . . .

The recent installation of modern Erie City 2-Drum Steam Generators at this Muskegon, Michigan plant provided "Undivided Responsibility" for Continental Motors Corporation. All the major components of these 100,000 lbs./hr. generators, including the boilers, air heaters, superheaters and stokers, were engineered and manufactured by Erie City Iron Works. Erie City also erected these generators and will provide any future service that is required.

Here at Erie City each component of our steam generators is designed to complement the other for maximum economy. Each component is engineered to meet specific performance requirements and to guarantee the highest efficiency. These and many more benefits are yours when you purchase complete steam generators by Erie City Iron Works. For a quick picture of our complete line of steam generating equipment write for Bulletin SB-50PE.

ERIE CITY
116 Years in Steam Generation

You can depend on Erie City for sound engineering

ERIE CITY IRON WORKS • *Erie, Pa.*

STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS
UNDERFEED AND SPREADER STOKERS • PULVERIZERS

data:

BOILERS, 2-DRUM
2 E. C. 100,000 lbs./hr.
Design pressure: 700 p.s.i.g.
Total steam temperature: 750° F.

AIR PREHEATERS
2 E. C. Single Pass

SUPERHEATERS
2 E. C. Pendant Type

SPREADER STOKERS
2 E. C. "Travegrate"

Continental Motors Corporation

RESPONSIBILITY—

BOILERS

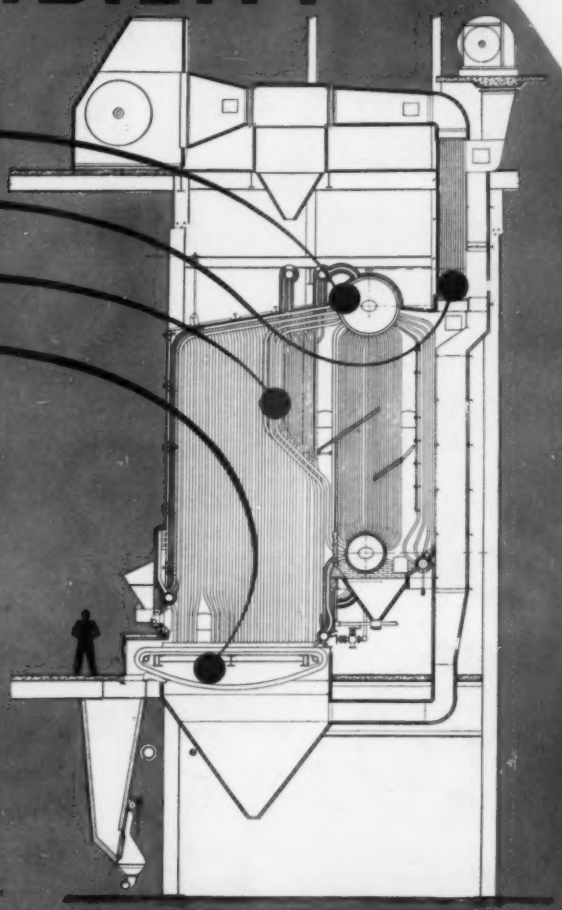
AIR HEATERS

SUPERHEATERS

STOKERS

ERECTION

SERVICE



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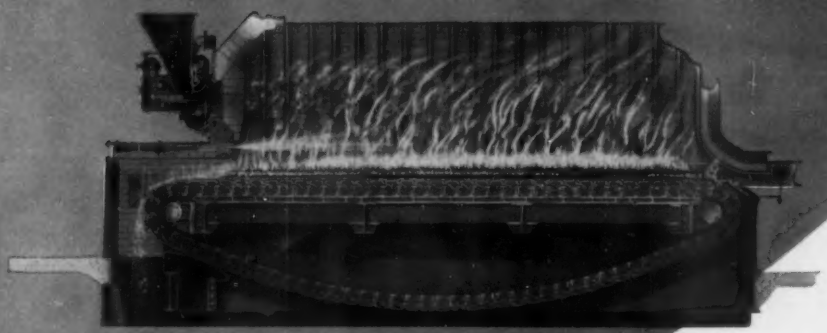

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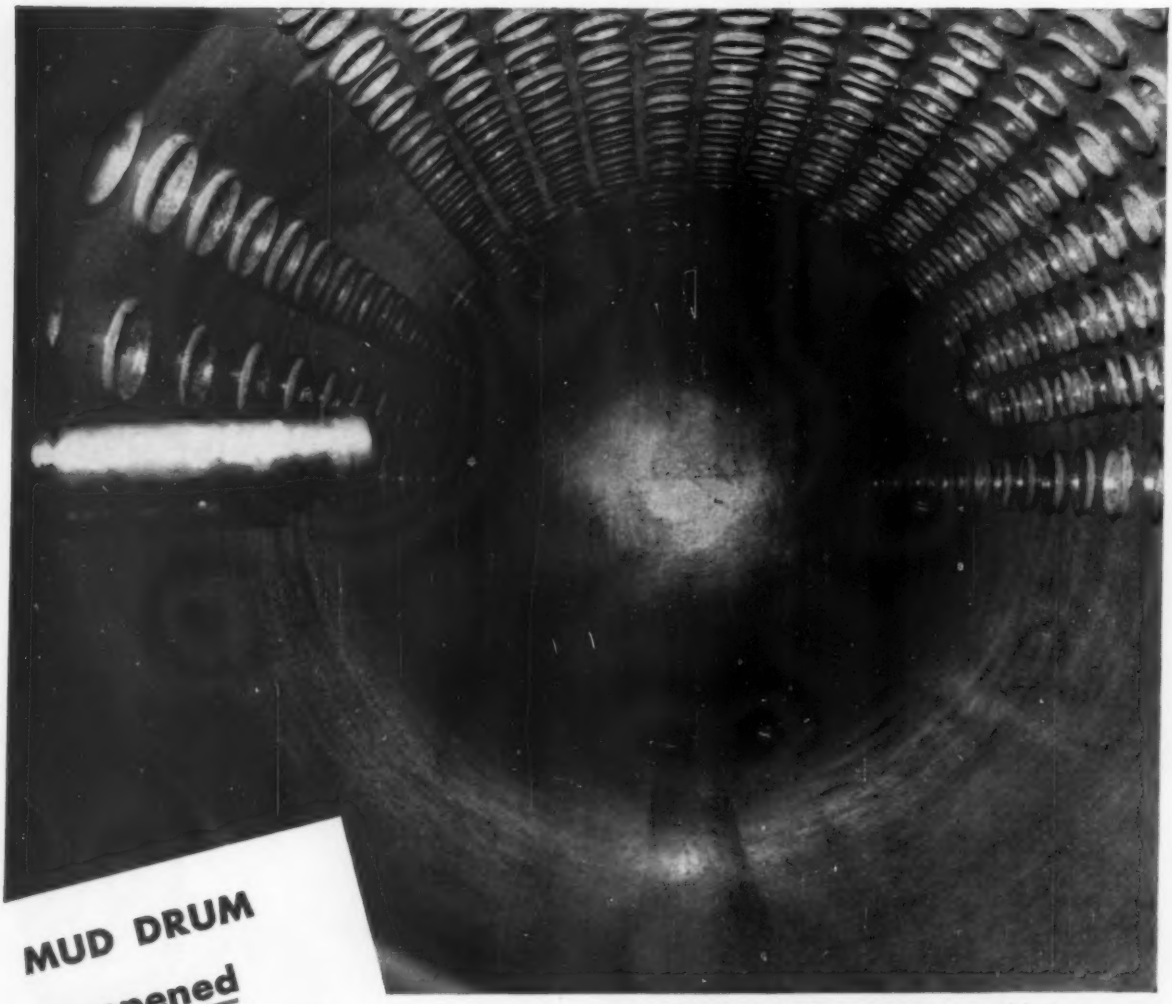

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HELPFUL BULLETINS

VALVES AND PIPING

101 Air Control Valves — Two-, three-, and four-way air control valves for high-pressure or low-pressure installations are described and illustrated in this 72-pp catalog. Includes cam, flow control, foot, hand, interlocking, pilot, pressure regulator, quick exhaust, sequence, solenoid, time delay and booster type valves. Also presented are single and double-acting cylinders for air or hydraulic use and strainers for pipeline protection. Each type of valve is treated separately, covering outstanding features, application data, dimensions, specifications and parts list. Airmatic Valve, Inc.

102 Diaphragm Motor Valve — Bulletin J-170 describes outstanding features of company's diaphragm motor valve designed for accurate control of pressure, temperature, rate of flow, and liquid level. Cutaway view showing component parts is included, along with data on materials of construction, capacity tables, and flow diagram. The Jordan Corp.

103 Control Valves — Eight-pp Bulletin 53C, on automatic pressure, temperature and level control valves for process control, is compiled specifically for power engineers concerned with special control problems. Bulletin describes a wide range of reducing valves, pump governors, relief valves, temperature regulators, feedwater regulators, float valves, damper regulators and combustion control valves for heating, power generation, chemical processing, other operations. Atlas Valve Co.

104 Jacketed Piping — Catalog 356, 26 pp, discusses design and applications of jacketed piping systems for the piping of high melting point products and viscous materials and for the cooling of materials as they are piped from one process to another. Piping layouts are included, as well as data on materials, fittings, plug valves, relief valves, pipe, flexible hose, expansion joints, basket strainers. Parks-Cramer Co.

WATER TREATING

105 Zeolite Softeners — Eight-pp Bulletin 105 describes principle of operation, applications and construction features of company's zeolite water softeners, engineered hydraulically and mechanically to provide optimum flow rates, maximum capacities of ion-exchange minerals, efficient utilization of the regenerant. Specifications, layout, dimensions and engineering data given. L. A. Water Softener Co.

106 Surface Type Deaerator — Publication 4654 describes a deaerator design best suited for hot water line protection in industrial plants and other types of buildings. Tells why this type of deaerator economically provides a supply of hot water free from objectionable odor or taste and fully deaerated to prevent corrosion. Cochrane Corp.

107 Cold Water Deaerator — Publication 4653 describes advantages of cold water deaerators and their principles of operation. Photos illustrate typical installations. Cochrane Corp.

MECHANICAL POWER TRANSMISSION

108 Multiple Drive System — Form F-1910 describes the Varidyne multiple drive system which provides simultaneous speed changes and equal distribution of load. Several examples of basic Varidyne applications are sketched and explained, and some actual installations are pictured. U. S. Electrical Motors Inc.

109 Fluid Drive — Eight-pp Bulletin 9819 describes company's 1- through 25-hp Type VS Class 2 Gyrol fluid drives, covering advantages and typical applications and design and general construction features. Cutaway view and close-up photos of optional speed control mechanisms are included, along with description of operation, selection tables, installation drawings. American Blower Corp.

110 Motor Pulleys — Eight-pp Catalog V-563 describes improved design features of the 800 series Reeves Jr. motor pulleys available in capacities from ¼ to 1½ hp and in speed ratios up to 2.75:1. Emphasizes use of a minimum number of pulley parts and outlines design features for increased rigidity and ruggedness and for improved disk lubrication. Also outlined is the simple operating principle and control of belt tension. Reeves Pulley Co.

111 Self-Aligning Couplings — Bulletin 60, 8 pp, describes company's self-aligning couplings which handle misalignment up to 3 deg at ordinary gear type coupling prices. Performance characteristics are fully detailed, cutaway photo showing inside construction is included, along with dimensional and specification data. Ajax Flexible Coupling Co., Inc.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 135 and 136

112 Dihedral Couplings — Eight-pp Catalog 62 features complete working data on sizes, capacities and dimensions of company's Series D-100 standard, floating shaft and mill motor type dihedral couplings designed to handle angular and offset misalignment up to a total of 12 deg. Photos and dimensional drawings included. Ajax Flexible Coupling Co. Inc.

113 Torque Converters — Heavy-duty, single-stage hydraulic torque converters for transmission of 100 to 1000 hp to industrial machinery are described in Bulletin 468. Gives features and specifications of 17 sizes and capacities for exact matching with engines in this power range. The National Supply Co.

HEATERS, HEATING

115 Storage Water Heaters — Standard commercial and industrial storage water heaters made by the company are the subject of Catalog 19. Tab-indexed for easy reference, this colorful, 48-pp catalog has been revised to include latest provisions of the 1952 ASME Code for unfired pressure vessels (U-69). Selection tables of capacities and weights, dimensions, hot water fixture capacities, material thicknesses, heating elements and construction details are offered, in addition to piping diagrams and installation suggestions. Conversion tables are supplied for calculation of capacities of heating elements under varying conditions. Effective control of corrosion with choice of five materials of construction is described. The Patterson-Kelley Co., Inc.

116 Plate Coils — How company's Platecoil, designed for heat transfer applications, saves engineering, fabricating, installation, operation and maintenance costs is detailed in 8-pp Bulletin IP-356. Applications are described and specifications and selection data are included, along with photos, drawings and pictures of typical installations. Platecoil Div., Tranter Mfg., Inc.

PUMPS, COMPRESSORS

117 Chemical Process Pumps — Bulletin B-1308, 12 pp, describes a concept of economy through interchangeability of components, a feature of company's Type DL and Type DM chemical process service pumps. Lists characteristics, tells how to order and assemble pumps on pump frames, and illustrates important design and construction features, with cutaway photos of component parts. Dimensions and performance charts are included. Peerless Pump Div., Food Machinery and Chemical Corp.

118 Hydraulic Pumps — Twelve-pp Service Manual S-1010 describes in detail disassembly and assembly procedures for maintenance and overhaul of Hydreco flange mounted pumps, foot mounted pumps, and foot mounted fluid motors. Cutaway view illustrating component parts is included, as well as a trouble shooting table, recommended wear tolerances, clearance chart, suggested test rack and test procedure and testing instructions, and a parts list. Kalamazoo Div., The New York Air Brake Co.

119 For Constant Displacement — Bulletin 46000 discusses advantages of company's constant displacement radial piston pumps, and covers construction, operation, speeds, capacity and pressure ratings. Photos and dimensional diagrams are included. The Oilgear Co.

120 Valves and Pumps — Catalog G-56, 16 pp, features company's diaphragm valves and metering and proportioning pumps. Included are specifications on diaphragm valves, tables of capacities on metering and proportioning pumps and complete information, including a schematic diagram, on company's pump for precision metering. Hills-McCanna Co.

121 Got Compressor Troubles? — Bulletin PC-509 is designed to help locate and correct common air-cooled and water-cooled compressor troubles. A cartoon

sequence pictures a full description of compressor troubles — from failure to deliver air to excessive oil consumption. Worthington Corp.

VIBRATION CONTROL

122 On Vibration Isolation — Bulletin 702, 16 pp, contains engineering data, performance curves, specification tables, details on design and use of plate form and multiplane mounting, a guide to selection and illustrated application and installation information. Introductory section discusses basic engineering principles of vibration isolation. Lord Mfg. Co.

123 Machinery Mounting — Containing an actual sample of Unisorb machinery mounting, this folder gives information and specifications on the various grades recommended for use under different types of machinery. Highlights advantages, gives load ranges, and includes ordering as well as complete specification data. The Felters Co.

ELECTRICAL

124 Variable Transformers — Catalog A56, 22 pp, features company's expanded and redesigned line of Adjust-A-Volt variable transformers in auto, isolated and metered models for bench and panel mounting. All single and ganged units are illustrated and described with photos, dimension drawings, wiring and circuit diagrams. Included are nine basic motorized variable transformers, complete specification and application index. Standard Electrical Products Co.

125 Voltage Stabilizing Transformers — Bulletin GEA 5754C, 16 pp, gives transformer's features and data on where to use the equipment. Includes operating characteristics and specifications, and is illustrated with application pictures as well as wiring diagrams and performance graphs. General Electric Co.

126 High Voltage Cables — Advantages of Anhydrex XX high voltage cables are discussed in this 8-pp booklet. Provides test data showing how these cables combat time and heat, are impervious to moisture, defy ozone and corona and offer increased service life. Selection data and specifications are included. Simplex Wire & Cable Co.

127 High Frequency Capacitors — Pyranol capacitors, generally designed for power-factor improvement in circuits operating at frequencies from 500 to 12,000 cycles per second, are described in Bulletin GEC 1346A. Applications with induction heating equipment for melting, forging and hardening operations are discussed, as well as series applications on the load side of a high-frequency generator, where they supply a reactive component to the generator windings and tend to neutralize its reactance. General Electric Co.

128 Cable Trough — Bulletin 256-F, 12-pp, describes cable trough and accessories for holding cables in all types of industrial applications. Advantages are listed and complete dimensional data is included, along with diagrams illustrating design features, specifications and other information. P-W Industries, Inc.

129 Splicing Kit — Instructions and application information for the entire line of Scotchcast splicing kits are presented in this 12-pp booklet. Describes in detail the Unipak container of electrical insulating resin No. 4 for pouring field-encapsulated splices and the three types of splicing kits with which it is used. Applications in which the electrical resin can be used for making poured splices without a splicing kit are also given. Minnesota Mining and Mfg. Co.

130 Insulation Products — Fabricating methods for electrical insulation parts are described in 20-pp Catalog 19, which includes specification data covering materials and their characteristics, as well as listing prices. Describes rag paper insulation strips and coils, plain or cuffed, creaser-cutter machines, crimped paper insulating coils, formed fibre slot wedges, hard maple wood wedges, asbestos base plastic wedges and others. Insulation Manufacturers Corp.

LIGHTING

131 Outdoor Lighting — Modern outdoor lighting for commercial and industrial applications is described in 12-pp Bulletin GEA-6438. Defines basic lighting terms and provides a guide for planning outdoor lighting installations. Typical applications are pictured, as well as such lighting equipment as fluorescent, mercury, and filament luminaires, floodlights, constant-current transformers, transformer controllers, and photoelectric controls. General Electric Co.

132 New Light Source — Long life, brilliance, and other advantages of the Fluomeric Lamp which lights without a ballast are presented in illustrated Form 579. Cutaway diagram illustrates component parts and operation principle. Duro-Test Corp.

ENGINES, TURBINES

133 Reheat Turbine — Titled, "Reheat . . . and Today's High Temperature Steam Turbine," Bulletin 03R8467 discusses evolution of this manufacturer's reheat turbine designs and contributing reheat experience during the last 25 years. Carries numerous installation photos and cross section drawings of the units discussed as well as cross sections through a barrel-type turbine for supercritical pressure application. Allis-Chalmers Mfg. Co.

134 Diesel Engines — This 14-pp bulletin describes manufacturer's 251 series of diesel engines in ratings from 550 to 2100 hp, and including a six-cylinder in-line model and 12- and 16-cylinder V-type engines. Bulletin provides photos of engine components and a cross-section cutaway of the V-engine type. Also includes specification tables. Alco Products, Inc.

SAFETY

135 Fire Alarm Systems — This 10-pp bulletin is designed for preparation of fire alarm specifications. It is concerned primarily with systems that warn all occupants of building being protected, such as would be installed in institutional and industrial plants. Application of National Fire Protection Association Code 72 is discussed in detail. Edwards Co., Inc.

136 Safety Solvent — Folder A-28 describes a detergent-action safety solvent designed primarily for the in-place cleaning of electrical equipment, also ideal for hand wiping of small parts, and many other cleaning jobs. Charts cover toxicity, flash point throughout evaporation cycle and evaporation rate. Turco Products, Inc.

137 Refrigeration Insulation — How company's Rock Cork refrigeration insulation provides fire safety is told in this informative bulletin. Describes such qualities as incombustibility, sanitation, high moisture resistance, low conductivity, long service life, high structural strength, immunity to rot. Johns-Manville.

Outstanding Among This Month's Catalog

138 Paint Work Book — Bulletin 760, about 12 pp, is a practical manual giving painting data in charts, tables, diagrams and illustrations. Factors relating to use of company's protective coatings in mild to severe corrosive service are covered. Coatings and related primers are presented, along with surface preparation, priming, application methods and maintenance instructions. Care and cleaning of brushes and spray equipment is explained. A table gives chemical resistance rating of each coating to over 200 corrosive agents. Limitations of each coating are also given and cost factors relating to specialized coatings are discussed. The U. S. Stoneware Co.

139 Expansion Joints — Catalog 56, 72 pp, covers design, manufacture and application of company's packless corrugated expansion joints, including self-equalizing, duo-equalizing and high pressure toroidal expansion joints. Profusely illustrated with photos, line drawings and schematic diagrams, catalog tells how various expansion joints can be used to absorb axial movement, lateral deflection and angular rotation in process piping systems. Tables and charts give engineering specifications and a selection chart tells how to choose correct type for given conditions. Thermal expansion values and recommended maximum and minimum temperatures for different piping materials are shown. Zallea Brothers.

140 Steam Condensers — Features and applications of company's line of steam condensers are detailed in this 24-pp illustrated bulletin. An engineering section offers formulas for determination of heat transfer rates, pressure drop, and other factors that apply specifically to the class of heat exchanger in which steam at high vacuum is condensed by cold water flowing through tubes. Air removal equipment, maintenance, steam condenser specialties are other subjects covered. Condenser Service & Engineering Co., Inc.

141 Tube Expanders — Catalog 88, 119-pp, is full of detailed information about tube expanders and associated tools used for tube rolling. Profusely illustrated, catalog provides information relative to boilers, condensers, evaporators or miscellaneous heat exchangers. Special sections are devoted to expanders, accessories, measuring instruments, rollers, extensions and drives. Each type of equipment is fully described, applications are listed, and tables of engineering data included. Also covers tube expansion methods, tool maintenance, expansion calculations and charts giving pipe and tube sizes. Thomas C. Wilson, Inc.

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STEAM GENERATORS by Vogt

a guide to advanced designs in package unit and custom built steam generating equipment

Vogt steam generating units are available in types and sizes to meet individual plant needs for power, processing or heating.

Package units range from 10,000 to 40,000 pounds of steam per hour while custom built units are obtainable in the larger capacities. Available in bent tube types and straight tube, forged steel sectional header types for solid, liquid or gaseous fuels burned singly or in combination.

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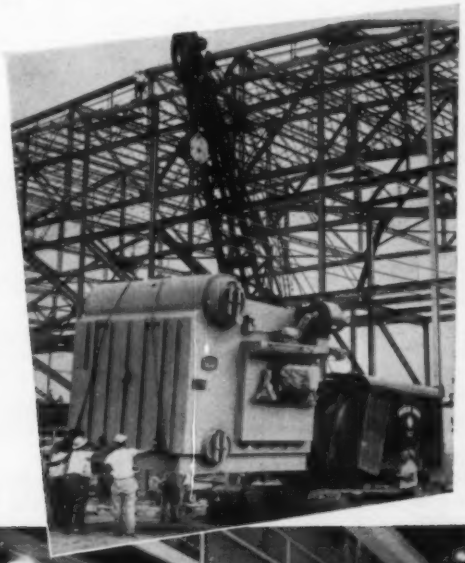

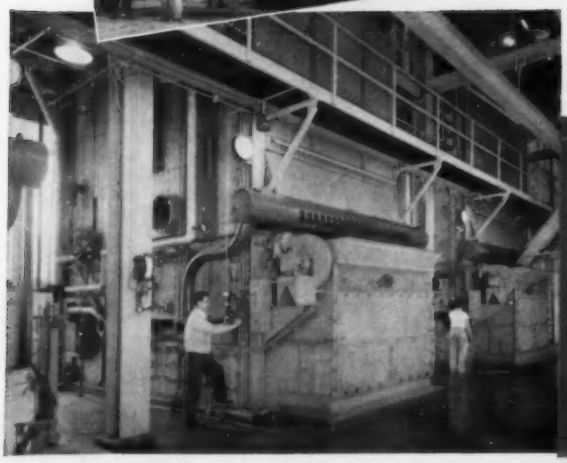

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Two of three 41,000 #/hr. steam generators installed in Medical Center Steam Plant, Louisville, Ky.

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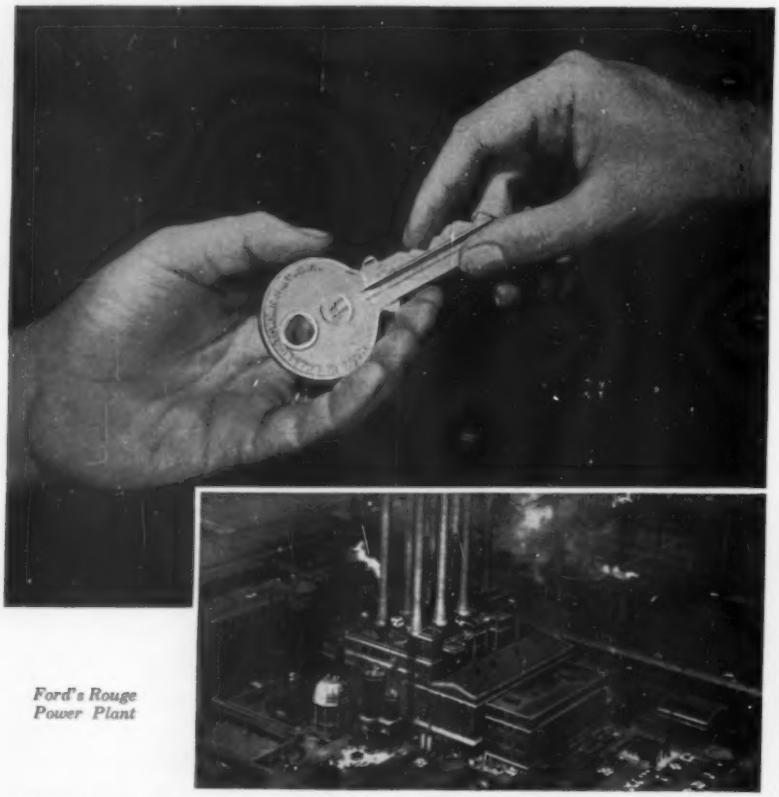

Ford's Rouge Power Plant

A Turn-Key project is a "packaged" service that combines engineering and construction in a single contract . . . and that may include other services such as preliminary investigations, studies and site selection, procurement of materials and equipment, initial operation of the finished plant.

Advantages to you:

LESS COST: Who is better qualified to construct a project than the firm that designs it? In a Turn-Key project one organization performs both engineering and construction services; details are handled quickly, efficiently—therefore more economically.

LESS TIME: Excavation can be made and foundations started several months prior to the release of the Engineer's completed design drawings and specifications. Construction follows blue prints—promptly. This scheduling of design and procurement to meet construction requirements permits the project to advance in an unbroken sequence—setting the stage for a faster delivery of the completed plant.

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We offer you engineering and construction services separately but suggest you consider combining them into a Turn-Key project that will save you both time and money. Write today for this free booklet describing the advantages in detail.

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INSTRUMENTS AND CONTROLS

142 Packaged Control — Bulletin GEA-6334, 12 pp, gives at-a-glance information on Pan-A-Trol packaged control for industry and lists benefits in engineering assistance, design, installation, maintenance, and field service offered by the company. Descriptive data covers types of devices used for a typical packaged control, and shows a case history of how special requirements are met. General Electric Co.

143 Instrument Panels — Power and process plants can choose instrument and control panels to meet individual specifications from six standard designs described in 16-pp Product Specification G71–7. Complete specifications are furnished, as well as information on supports and mountings for tubes, wires and equipment, instrument mounting dimensions, and dimensions of standard instrument and control panels. Bailey Meter Co.

144 Flow Rate Regulators — Direct-acting flow rate regulators for clear liquids, light slurries and many suspensions are the subject of 6-pp Form 551. Operating principle, maintenance economy, construction, and installation are discussed, capacities are given, and a cutaway view showing component parts included. Typical applications are described and performance characteristics indicated on curves. W. A. Kates Co.

146 Meters and Controls — Over 100 measuring, transmitting, receiving, recording, and indicating instruments and control components for power and process applications are described in 8-pp Bulletin G15-1. Includes detailed literature reference for each product as well as application suggestions. Bailey Meter Co.

147 Cooling Controls — Bulletin 710B describes company's self-powered cooling controls for compressors, stills, solvent coolers, degreasers, oil coolers, small engines, condensers, others. Includes operational drawing and hook-up sketches. Sarco Co., Inc.

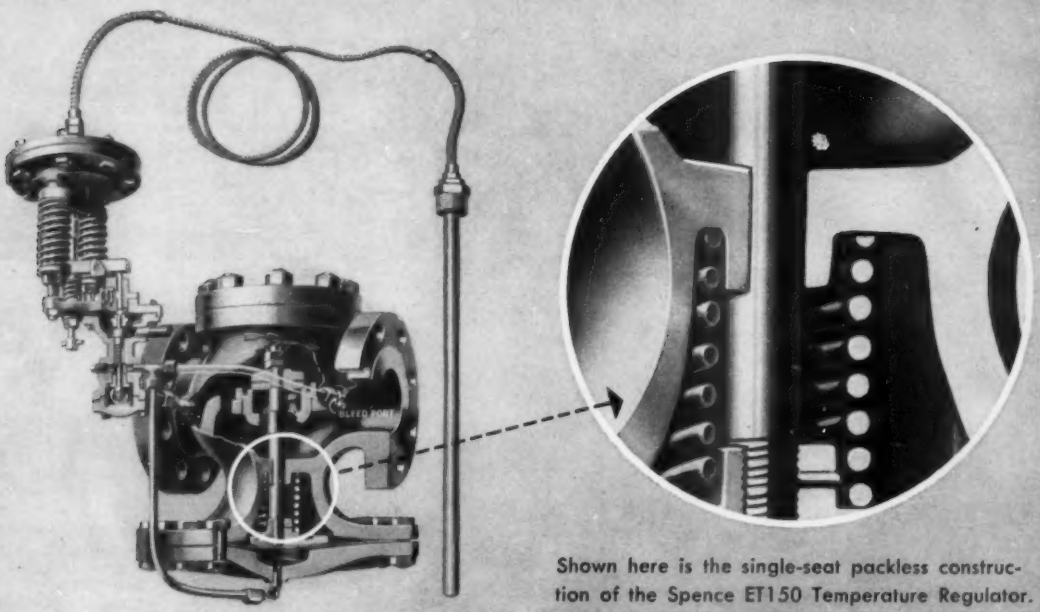
148 Service Cocks — A line of service cocks, meter and air cocks for moderate-pressure services, such as gas, water etc., are described in 12-pp Bulletin V-605. These cocks are also suggested for use in a number of low-pressure industrial applications. Principal emphasis is given to a service cock specially designed to eliminate the menace of tampering. Lubricant and accessories are also described. Meter and Valve Div., Rockwell Mfg. Co.

149 Thermal Conductivity Analyzer — Versatility and accuracy are among advantages of the Model 7C thermal conductivity analyzer described in Bulletin 119. Operating principle is illustrated, typical applications are highlighted, and technical data given. Arnold O. Beckman, Inc.

150 Control Fundmanetals — Three important factors in combustion control — safety, efficiency and long life — are considered in detail in 16-pp Form EB-1-756, the first of a series. Reviews basic concepts involved in automation in combustion, or the provision of automatic means for sensing heat requirements to assure correct proportioning of fuel and air under optimum conditions. Fundamentals of controls common to all systems are considered, units whose function is to facilitate control by adding, subtracting,

VALVE TIPS:

Advantages of Packless Construction in Temperature Regulating Valves



Shown here is the single-seat packless construction of the Spence ET150 Temperature Regulator.

One of the biggest headaches in regulating valve maintenance is repacking stuffing boxes.

How often a valve needs repacking, how much time it takes, and the cost of the system downtime all vary with the construction of the regulator and the service it's used for. No matter how you calculate all these variables it's still a headache—and an expensive one.

In the temperature regulator shown above (Spence Type ET150) stuffing boxes are eliminated. This is done by what is known as "balanced" diaphragm construction. You can see in the cutaway drawing that pressure is applied to both sides of the large metal diaphragm. The upper side is exposed to delivery steam pressure and the lower side is exposed to loading pressure applied by the pilot. When the pilot closes, both delivery pressure and loading pressure are equalized through the bleedport and connecting tubing.

This construction not only does away with repacking problems, but it makes possible additional savings as well. For example, you will note in the sectional blow-up that this design eliminates a closely fitted stem and guide. Dirt or other foreign matter doesn't have much of a chance to lodge between these parts and cause sticking.

Another cause of binding or sticking, uneven expansion of closely fitted parts, is also eliminated with this design. In addition, valve stem wear is reduced for the same reason.

Lower maintenance is not the only advantage of this packless construction. Accuracy of regulation is also improved because friction due to a stuffing box, dirt, or uneven expansion is not a problem. The large, balanced metal diaphragm is more sensitive to slight changes in pressure.

Guaranteed Not To Wiredraw

If seats and discs are cut by steam (wiredrawn) the loss of steam through these grooves can be another expensive item — directly charged against the regulating valve. Fortunately, you can eliminate these costly leaks by specifying a temperature regulator that is *guaranteed not to wiredraw.*

Spence makes such a guarantee because their seats and discs are made of SECO Metal. Over 20 years experience with this special alloy has failed to produce a single case where a SECO Metal seat or disc had been cut by steam. All that's required is an approved strainer located ahead of the regulating valve. Expensive steam leaks just can't happen with this combination of SECO Metal and single-seat design.

If you would like to have more information on Spence Temperature Regulators, drop us a line and ask for Bulletin T150. It gives more detailed information on these and other Spence design features. Piping layouts and helpful information on the installation of temperature regulators are also included. Write for your copy today.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York

SE 140

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J-M dust control equipment was installed because of its high effectiveness and unusual flexibility of application. This is only one of many examples of how a Johnson-March system effectively solves dust problems for power stations and industrial plants.

J-M Dust Control costs only 1/10 as much!

No costly ducts, hoods, or fans. Almost no maintenance. An economical Johnson-March system can eliminate fire and explosion hazards, community dust nuisance, safety hazards, and maintenance problems. Even the efficiency of existing mechanical dust collectors can be improved by the addition of a J-M liquid system at low cost. Call or write — for an obligation free analysis of your problem of controlling dust, fumes or odors.

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multiplying, dividing or ratioing control signals are evaluated, and a dictionary of control terminology is included. Cleveland Fuel Equipment Co.

151 Combustion Controls — Bulletin CG-72 is a concise 20-pp price manual covering company's entire Fireye product line. It will aid in ordering new equipment and parts and serve as a condensed reference. Sections in the booklet pertain to panel control systems, flame safeguards and programming controls, flame indicators and alarms, flame scanners, control enclosures, operating controls and limit switches, smoke density indicators and recorders, others. Combustion Control Div., Electronics Corp. of America.

152 Smoke Controller — Data Sheet 10.14-2a describes the revised Brooke Smoke Density System using company's Electronik recorders. Design and operation characteristics are discussed, as well as features which contribute to ease of installation and maintenance, and long life. Industrial Div., Minneapolis-Honeywell Regulator Co.

153 Automatic Burner Control — Bulletin CF-21 describes Fireye primary control system for light oil or gas-fired automatic commercial burners. Full operating data is included, illustrated with photos and drawing, and containing dimensional drawings and specifications. Combustion Control Div., Electronics Corp. of America.

154 Heat Sensitive Resistors — Characteristics and applications of Thermistors — thermally sensitive resistors for automatic detection, measurement and control of physical energy — are described in 53-pp Manual Th-13A. Features the latest general, material and operating characteristics of the electronic semiconductors, as well as general types of applications. Besides basic data, it also includes details on Thermistor assemblies, static and dynamic characteristic curves in addition to ordering information. General Electric Co.

DUST CONTROL

155 Dust Collector — Bulletin 920 describes a dust collector designed for the wet collection of industrial dusts. Drawings and photos illustrate operation, and dimensions, weights and capacities furnish additional information. Pangborn Corp.

156 Cupola Dust Control — Dust Control Bulletin 292 describes operation of company's dry-type centrifugal dust collector designed to handle large exhaust volumes of granular dust such as those found in cupolas or boiler stacks. Explains how counterweighted caps are added to the cupola tops and cupola stack gases are pulled through damper section where initial flash cooling occurs. A diagrammatic drawing details operation features. American Air Filter Co., Inc.

CONSTRUCTION

157 Floor Plate — Bulletin AD-206 describes a floor surfacing armor which is economical and will add substantially to the life of heavy-traffic industrial cement floors. Simple instructions and illustrations reveal economy, durability and ease of installation of the product. Acme Steel Co.

158 Faced Steel Plate — Catalog MRG-444 describes advantages of rubber

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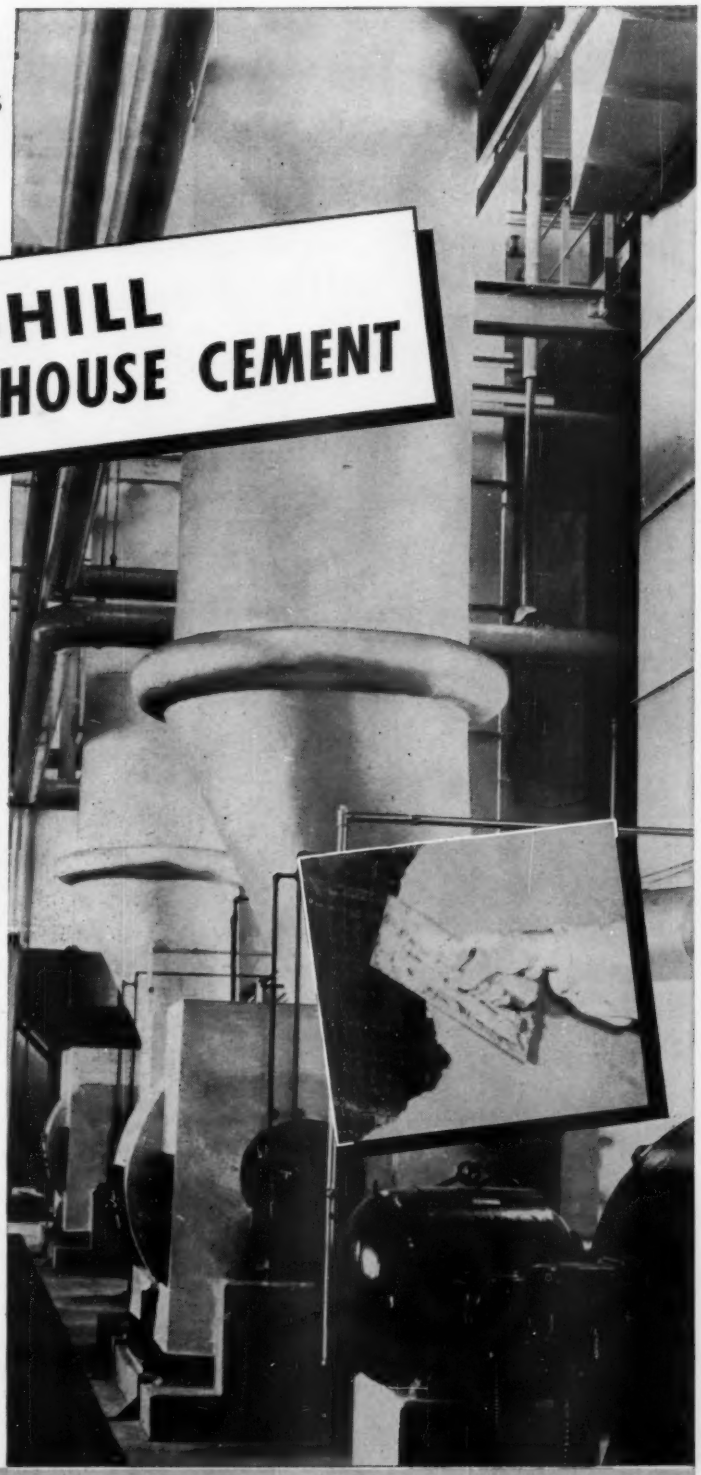
BALDWIN-HILL SUPER POWERHOUSE CEMENT



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- Dries quickly to a smooth, glazed white surface that may be painted with water or oil-base paints. Aluminum paint used on this application.
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B-H Bond-Tite	B-H Spun Felt Insulation	B-H Mono-Kover Pipe Insulation
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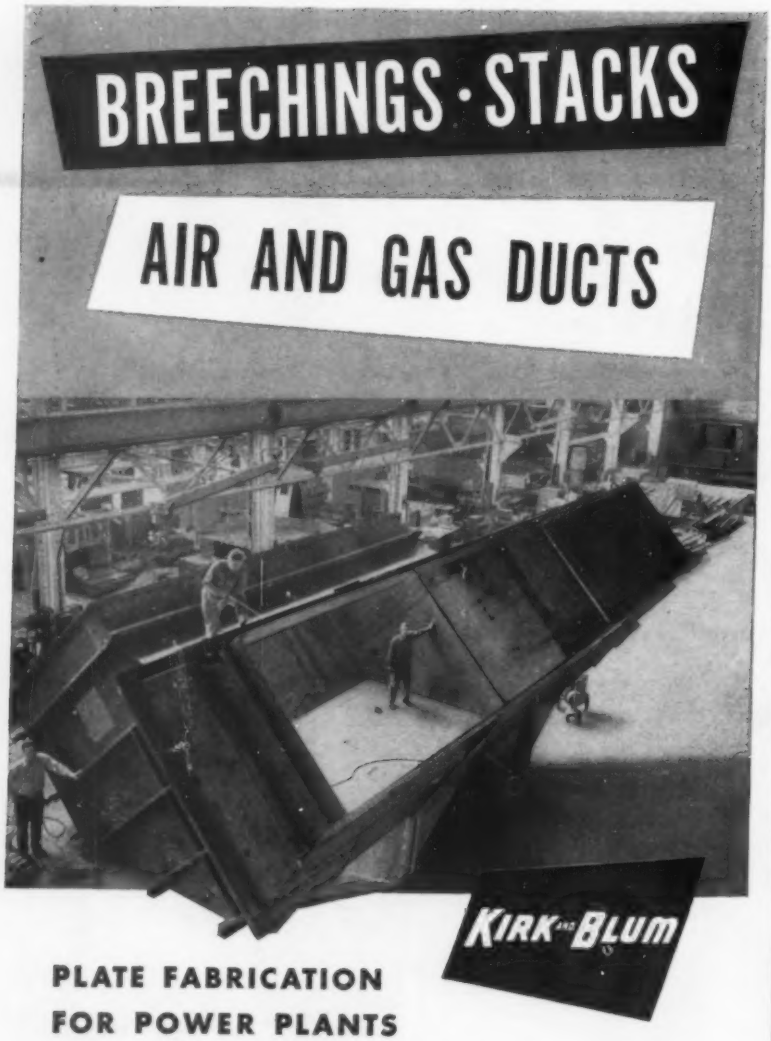

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Kirk & Blum has fabricated a variety of power plant needs as big as the mammoth breeching section shown here. In a 150,000 sq. ft. plant, with crane capacity to 25 tons, Kirk & Blum has complete facilities to produce, pre-assemble and load the largest fabrication. Kirk & Blum has the men, materials and experience to do the job quickly and economically.

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FABRICATION

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faced steel plate in applications where abrasion wear, impact wear, and corrosion are a problem. How various industries are cutting maintenance costs with the use of this plate is detailed, covering the handling of sand, gravel and concrete, metal-working, coal handling, chemical, and material handling, others. The Gates Rubber Co.

OTHER EQUIPMENT

161 Industrial Packings — Performance characteristics and applications of company's packings are described in 18-pp Catalog PC-102, covering self-lubricating packings, molded packings, sheet packings and gaskets, folded asbestos packings and gaskets, asbestos rope and wick. Photos, cutaway views showing construction features, dimensional data, application chart included. Greene, Tweed & Co.

162 Welding Directory — Specific types of work and properties of various types of weld metals are described in 28-pp Catalog SB-1352. Features electrodes for the welding of stainless steel, non-ferrous weld metals, cast iron, and hard surfacing, and describes applications of each, properties of deposited metal, hard surfacing, with a hard surfacing guide included. The Lincoln Electric Co.

163 Refractory Cement — Heavy duty brick bonding and patching mortar is described in this 8-pp illustrated color folder. Includes success stories concerning the product's application in high temperature work and in the protection of equipment against slag, fly ash and gases. Refractory and Insulation Corp.

164 Refrigeration Condensers — Form G-141, 24 pp, describes company's ¼- through 3-hp line of semi-hermetic condensing units and high torque motor compressors. Photos of each flat base and raised base model are included, as well as top and side schematic views, temperature applications, specifications, capacity data, temperature ranges and electrical characteristics for motor compressor units. The Brunner Co.

165 Industrial Equipment — Condensed Catalog 53I, 50 pp, contains technical data, brief description and photos of vibratory materials handling equipment — vibrators, feeders and screens, other industrial equipment — shaft seals, selenium rectifiers, diesel pile hammers, and power tools, gasoline hammer drills, electric hammers. Syntron Co.

166 Wet Back Boilers — Catalog AP-295A gives product description, plus dimensions and engineering data, to help in specification and installation of company's 900 Series "wet back" Scotch type boilers, engineered for natural draft applications. Specification and heater data are tabulated. Pacific Steel Boiler Div., National-U. S. Radiator Corp.

167 Calcium Base Grease — Technical Bulletin 46 describes a grease compounded to stay put under the worst conditions of dirt, moisture, low speeds, and high loads. Covers applications, physical properties, advantages. Sun Oil Co.

168 Welded Tubes — Bulletin TB-412 describes advantages of electric resistance welded carbon steel tubing in applications involving heat transfer. A chart outlining the hydrostatic test pressures required for the various sizes of tubes under ASTM A-214 is also shown. Tubular Products Div., The Babcock & Wilcox Co.

From the inception of nuclear engineering at Stagg Field, Chicago, to current power and research installations, Stone & Webster Engineering Corporation has been engaged in engineering and construction for nuclear projects.

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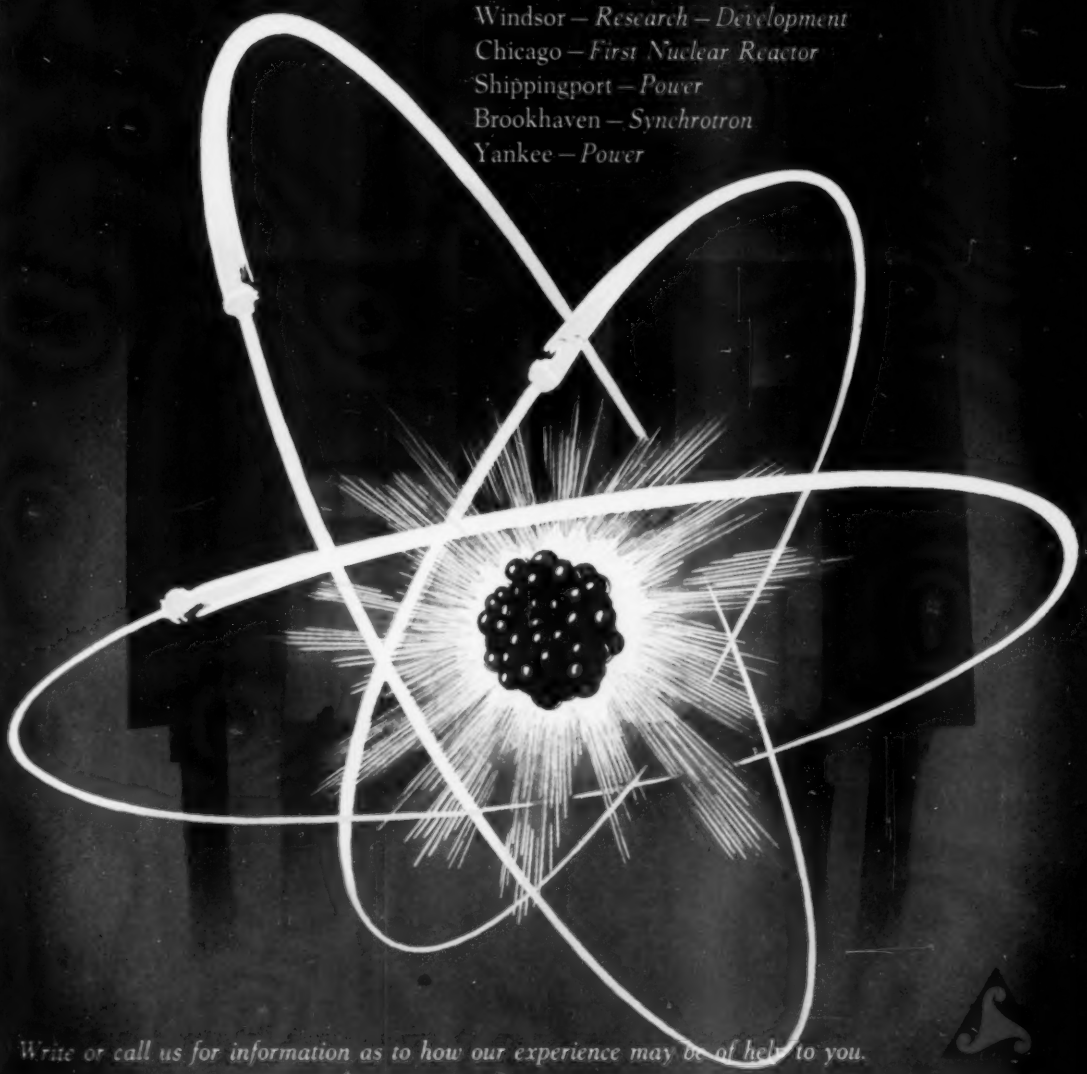

Write or call us for information as to how our experience may be of help to you.

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Powell Lubricated Plug Valves

Fig. 3059 (Sectional) A.S.A. 300-pound Steel Lubricated Plug Valve

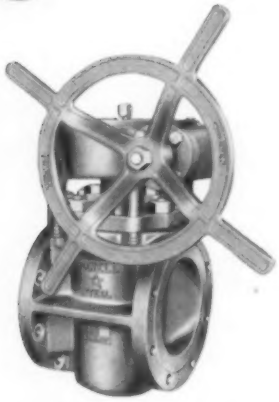

FIG. 1559G—150-pound Steel Lubricated Plug Valve. Gear operated

FIG. 2200—175-pound W.O.G. Semi-Steel Lubricated Plug Valve

PERFORMANCE PV VERIFIED

Powell Lubricated Plug Valves maintain the 110-year tradition of quality and precision. Only the finest available materials are used. And painstaking quality control is rigidly enforced through each and every step of manufacture.

Valve users who want one source of supply for lubricated plug as well as all types of bronze, iron, steel and corrosion-resistant valves will want full details on Powell Lubricated Plug Valves.

For example, features include quick and positive operation—just a quarter-turn to open or close. Lubricant grooves surrounding each port provide a positive seal when the valve is closed. In an open position, seating surfaces are not exposed. Available in Steel and Semi-Steel through distributors in principal cities.

For full details, write for the new PV-4 Catalog on Powell Lubricated Plug Valves. Just fill out the coupon and mail. Of course there's no charge, no obligation.

THE WM. POWELL COMPANY
2525 Spring Grove Ave.
Cincinnati 22, Ohio

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Please send me a copy of your PV-4 Catalog on Powell Lubricated Plug Valves. It is understood that there is no cost, no obligation.

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The source of supply for all valve needs!

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BRONZE, IRON, STEEL AND CORROSION RESISTANT VALVES.

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LIQUID PROPORTIONING

for systems requiring limited capacities

Compact and simplified, the all-new Hills-McCanna model 4411 chemical metering pump brings a new standard in precision metering. Features typical of larger Hills-McCanna models are retained—now for the first time, saving features of smaller installations are offered.

A single or double feed, positive displacement, plunger type pump, the model 4411 provides continuous proportioning of chemicals for water conditioning, waste treatment, chemical additive feeding and similar applications. Ease of capacity adjustment and simplicity of maintenance are provided for in the simple stroke adjustment and "capsulated" construction of the reagent end.

For new cost savings in liquid proportioning, consider the model 4411 and all its economical features. Contact Hills-McCanna today!

Off the shelf delivery . . . is yours with the model 4411.

WRITE TODAY *for full information on this remarkable new metering pump. Ask for Bulletin No. 601.*

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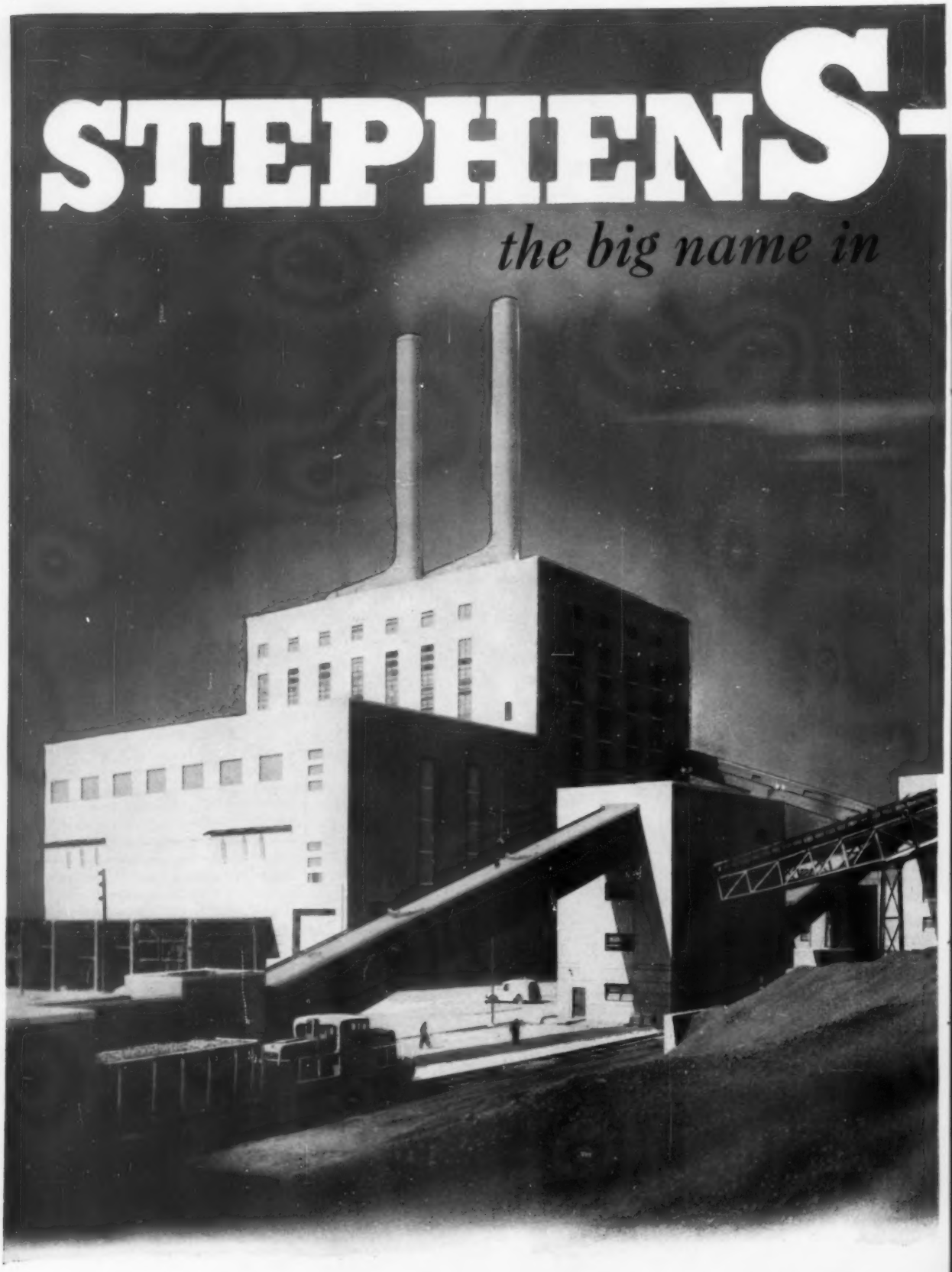
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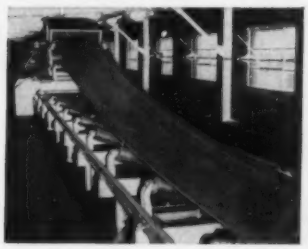
coal conveying systems for power

To squeeze every last kilowatt from every ton of coal consumed, power producers know the conveying system must be right. It means a system properly engineered to the specific need with low initial installation cost. It means one that requires minimum maintenance and operational manpower for years to come.

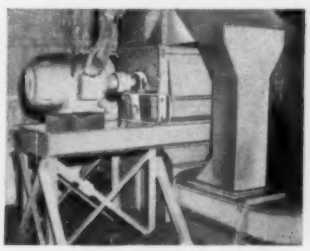
S-A engineer strategists have been planning and building such conveying systems for over fifty years. At this very moment, many of them are helping to provide cheap power in hundreds of private and utility power plants all over the world.

Stephens-Adamson sales engineers, backed by the most complete line of manufactured equipment, blanket all important industrial areas. They can show you why it pays to convey with S-A.



An S-A belt conveyor brings coal into a mid-west power plant. A belt tripper deposits the fuel into bunkers through traveling tripper spouts.

S-A Redler conveyors provide dust-tight coal movement from storage bunkers. Redler designs permit easy coal movement over horizontal, vertical, or inclined planes.



An institutional power plant employs S-A Knittel crusher to reduce coal lump size. It will handle damp coal without plugging or decrease in capacity.

S-A manufactures a wide range of material handling products in three complete plants in U. S. and Canada.

- Belt Conveyors
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- Stacking Conveyors
- Storage & Reclaiming Systems
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- REDLER Conveyor-Elevators
- ZIPPER Conveyor-Elevators
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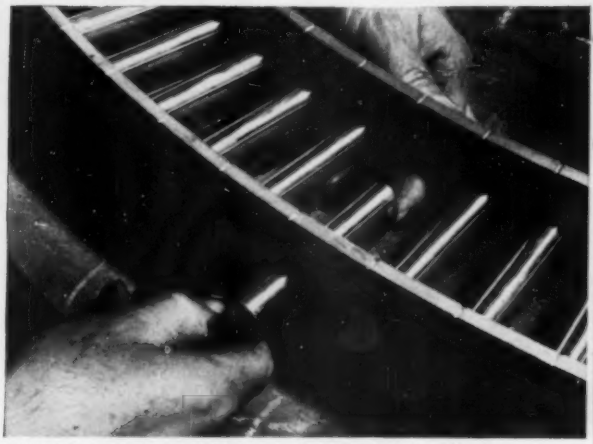
Building Tomorrow's Turbine-generator Today



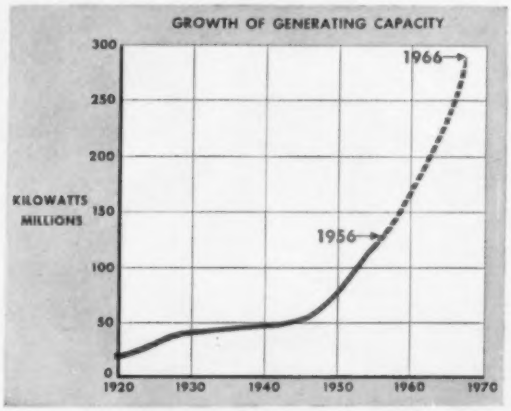
THE HIGH-PRESSURE END DIAPHRAGM WEBS are made from heavy alloy steel plates or castings. Some are ten inches thick and can withstand high pressure drops and maintain close clearances.

THE WEB is then carefully machined for welding (top). Nozzle partitions are machined from solid chrome-iron alloy and assembled in punched bands (bottom).

How General Electric builds sturdy nozzle-

TO MEET TOMORROW'S EXPANDING LOADS

GENERAL ELECTRIC MAINTAINS a continuing program of research on turbine diaphragms. This smoke tunnel provides a visual indication of how steam flow will follow new nozzle designs.



G.E. works with electric utilities and consulting engineers in these vital turbine-generator areas:

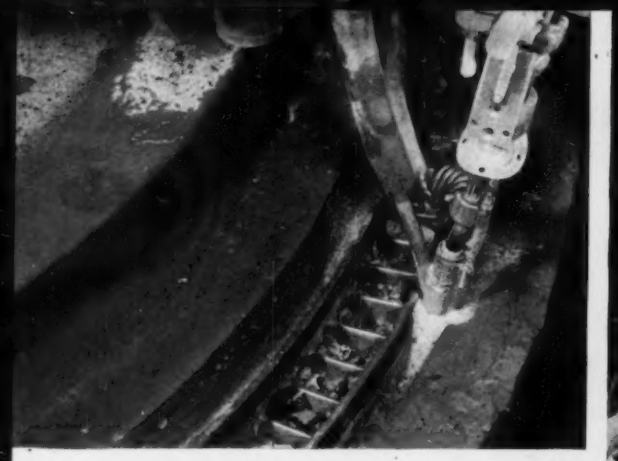
BASIC RESEARCH

APPLIED RESEARCH

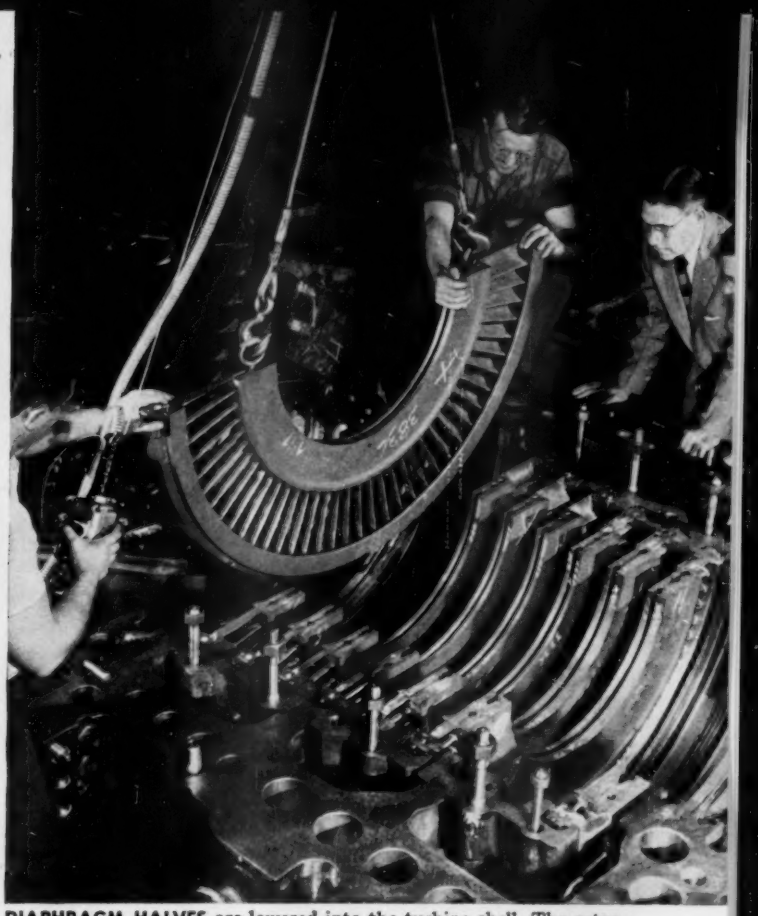
PRODUCT DEVELOPMENT: NOZZLE-DIAPHRAGMS

TESTING

MAINTENANCE



THIS NOZZLE assembly is welded to the web and outer ring (top). A finishing operation puts a high polish on the partitions for a smooth steam path (bottom).



DIAPHRAGM HALVES are lowered into the turbine shell. The rotor is then assembled and the upper shell containing the top half of the diaphragm is added to form a series of complete compartments.

diaphragms to reduce turbine maintenance

TOUGH CONSTRUCTION HELPS PROTECT STEAM PATH AGAINST DESTRUCTIVE FOREIGN MATERIALS

Internal damage to the steam path can be a costly and time consuming cause of turbine shutdown. Should large amounts of foreign material enter the steam path whole rows of buckets and partitions might be severely damaged. This could mean a long and costly outage.

TO HELP GUARD against a long outage, General Electric builds turbine nozzle-diaphragms of tough, sturdy construction. And here's how they help. Should foreign materials enter the steam path, these rugged nozzle-diaphragms "compartmentalize" damage to a small area. This greatly simplifies bucket repairs or replacement.

GENERAL ELECTRIC MANUFACTURES these diaphragms from solid castings or plates carefully machined to shape. Nozzle partitions are machined from solid chrome-iron alloy and welded to, or cast integral with, the webs. These partitions must direct the steam flow at the proper angle and velocity to the adjacent buckets.

In this and many other areas of research G.E. is working with electric utilities and consulting engineering firms to design the power makers for tomorrow's load growth. For more information on General Electric turbines write for GER-905, Large Steam Turbine-Generator Department, General Electric Company, Schenectady 5, N. Y. 254-40

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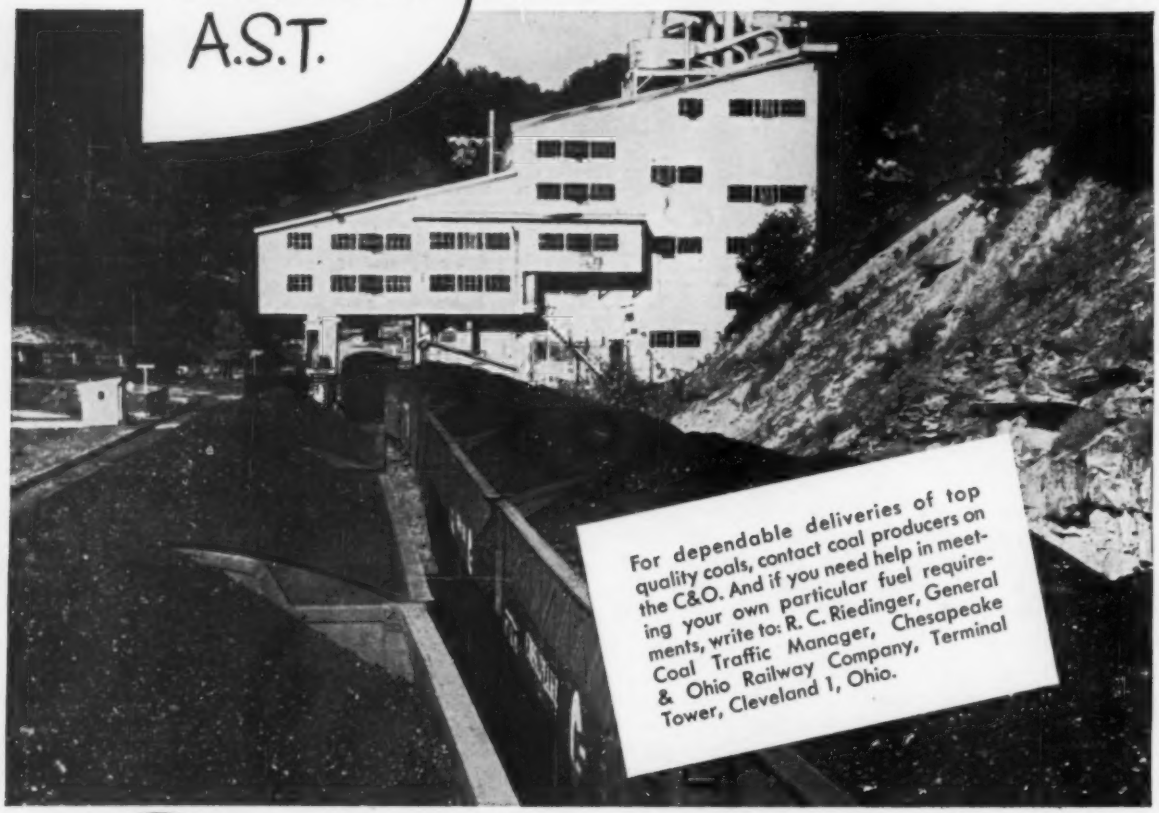
. . . the modern, efficient mines on the C&O can produce just what you want.


For dependable deliveries of top quality coals, contact coal producers on the C&O. And if you need help in meeting your own particular fuel requirements, write to: R. C. Riedinger, General Coal Traffic Manager, Chesapeake & Ohio Railway Company, Terminal Tower, Cleveland 1, Ohio.

Chesapeake and Ohio Railway

WORLD'S LARGEST CARRIER OF BITUMINOUS COAL

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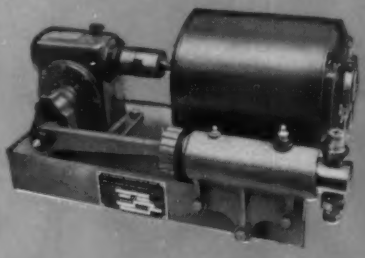
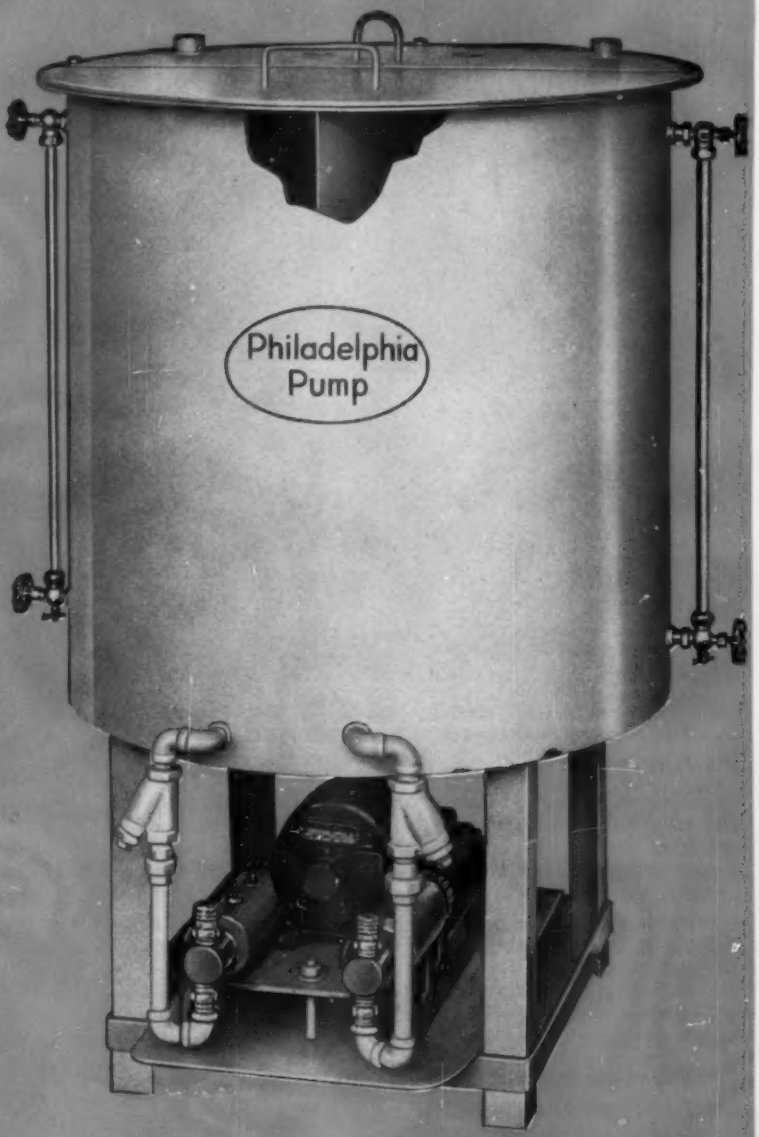
pump or packaged unit





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most dependable, low-cost means of feeding water-treating chemicals.

Made by the makers of the most complete line of controlled capacity chemical pumps.

● Self-contained chemical feed units comprise single or divided welded steel tanks, simplex or duplex PHILA-FEEDER pumps, gages, strainers and all necessary piping for proportioning chemicals into plant system.

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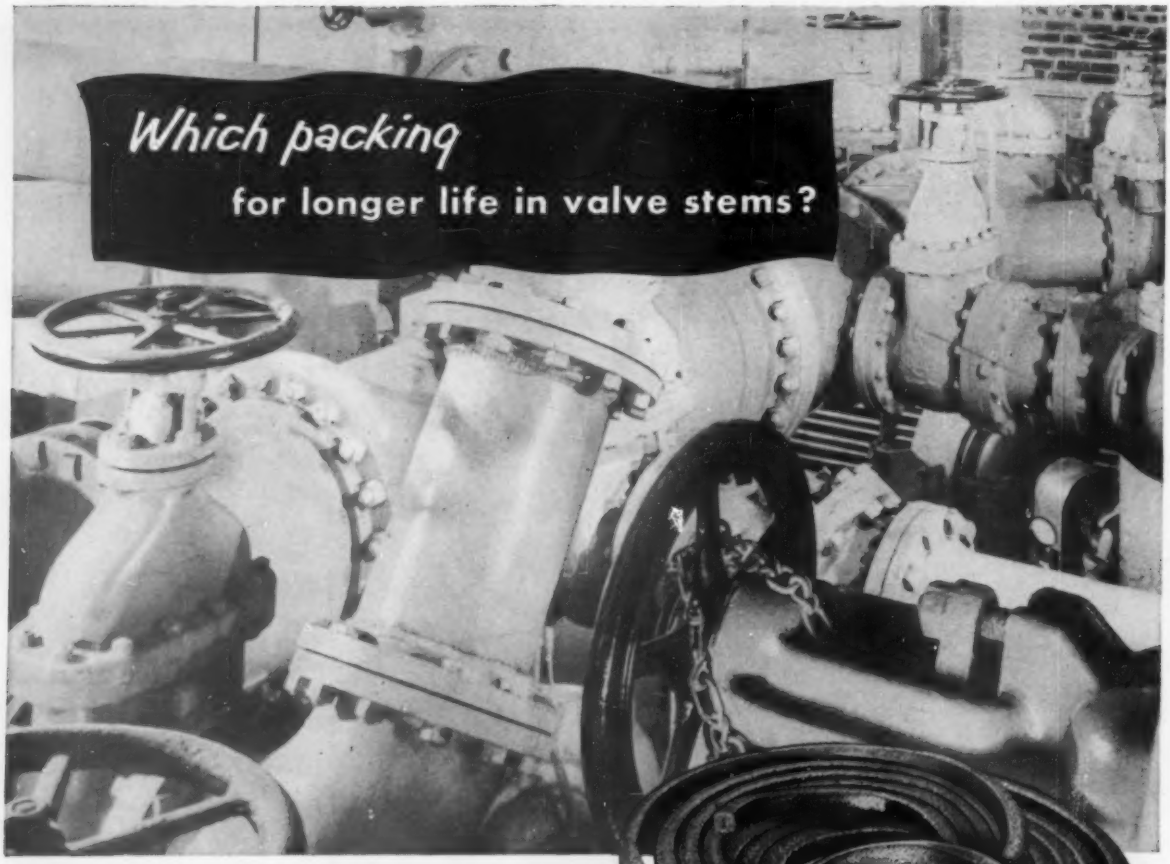

. . . for heavy fluids, steam, water and gas . . . *it's J-M Jewett®*

Strong, tough Jewett has been proven the ideal packing for heavy duty valve stem service against crude and heavy oils, tar, molasses and other heavy gummy fluids. It also provides efficient sealing against steam; fresh or salt, hot or cold water; air; gas and some chemicals requiring a packing free from rubber.

The basis of Jewett's exceptional durability is its construction of high-quality long fibre asbestos yarn with fine copper wire inserts. This yarn is braided over a lead ribbon core and formed square. Style 10 is treated with a heavy bodied, heat-resisting lubricant which won't bleed in valve stem service. Furnished graphited in coil or ring form in sizes from ⅛″ up.

. . . for superheated steam and gases to 900F *it's J-M High Temperature*

When valves are operating in high temperature service, your best packing choice is Johns-Manville High Temperature Style 398. It retains its resilience, holds a tight, lasting seal against superheated steam and dry gases under elevated pressures and temperatures up to 900F.

To obtain this high sealing efficiency, Johns-Manville braids asbestos yarn of high purity over a plastic core of special heat resistant composition. For extra strength, the yarn is reinforced with tough heat and corrosion resistant Monel wire. The packing is formed square and then lubricated with mica. Furnished in ring, coil and spiral form in sizes ¼″ to 1″.

Your local J-M distributor carries full stocks of Jewett, High Temperature and other packings. Call him today or write Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario.

Johns-Manville PACKINGS, GASKETS and TEXTILES

JM PRODUCTS

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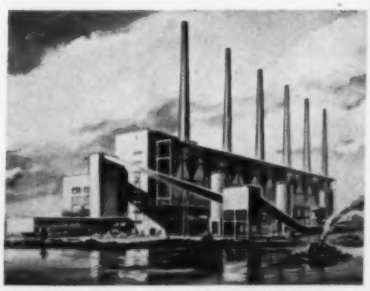
Anaconda tubes of Arsenical Admiralty-439 in the process of being installed in the exhaust condenser at River Rouge.

Nation's largest exhaust condenser at new 260,000-kw T. G. River Rouge Plant uses Arsenical Admiralty Tubes



Sketch of The Detroit Edison Company's great River Rouge generating plant as it will look when completed. Sketch shows the ultimate 6-unit plant; only 3 units are being constructed at this time.

WHEN the Detroit Edison Company's new River Rouge plant was placed in operation recently, the exhaust condenser of its 260,000-kw first unit became the largest in the country.

This huge Allis-Chalmers condenser has a total cooling surface of 115,000 square feet. The American Brass Company supplied 19,850 tubes of Arsenical Admiralty-439, each ¾" O.D. by 0.049" (18 BWG) by 30' long—for a total weight of approximately 250,000 pounds.

The American Brass Company is constantly studying corrosion problems affecting condensers and heat exchangers—and is a leader in the development of alloys to help meet these problems. Arsenical Admiralty-439 is but one of its many contributions in the field.

The metallurgical engineers and sales representatives of The American Brass Company are available to help you in the selection of the Anaconda Condenser Tubes to meet your specific needs. Write: Technical Department, The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

ANACONDA®

TUBES and PLATES for CONDENSERS and HEAT EXCHANGERS

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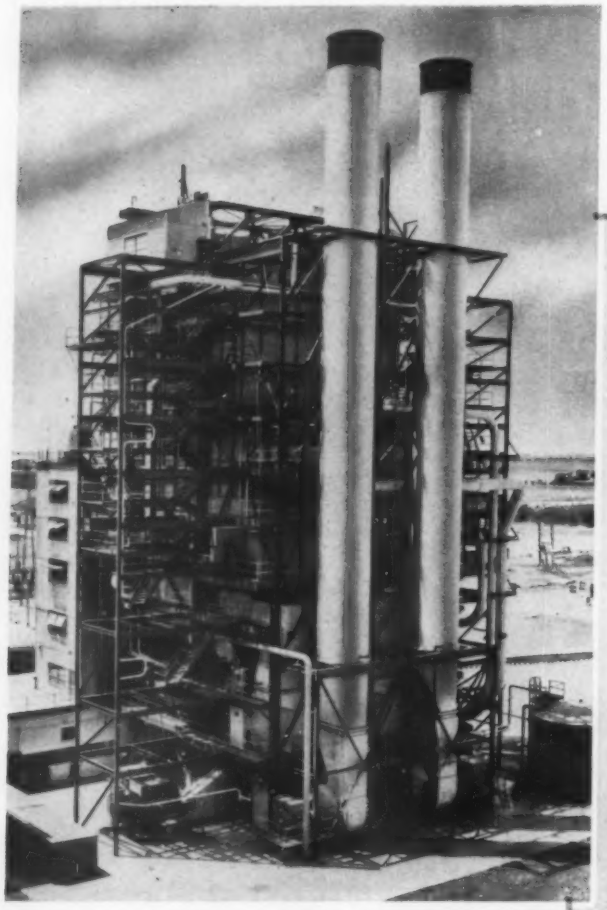
Kansas Gas and Electric puts third*

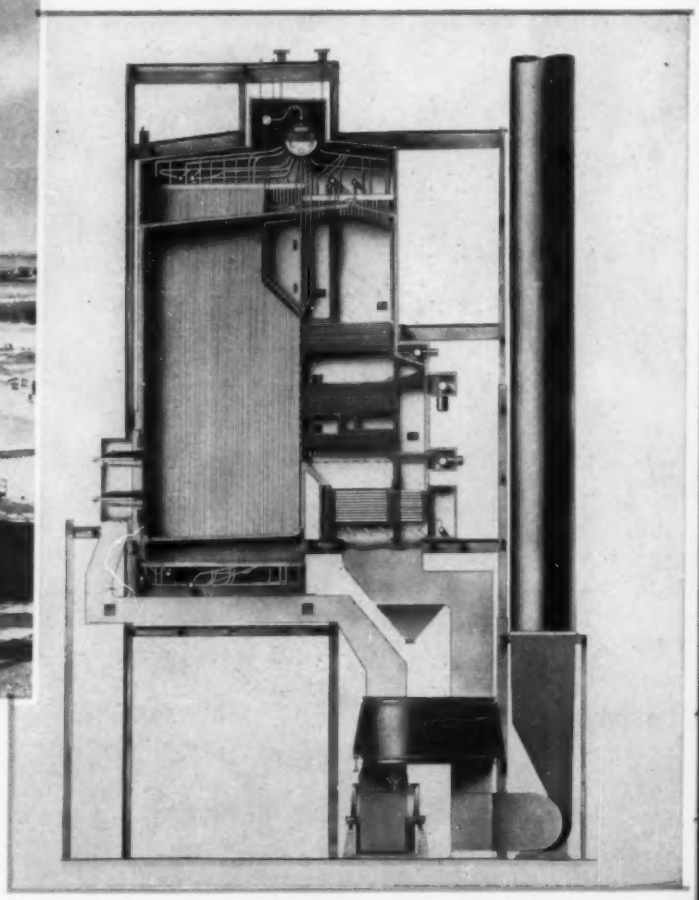
FW steam generator "on stream" to help...

MEET GROWING DEMAND



Foster Wheeler steam generator, unit no. 3, at the Murray Gill Station of the Kansas Gas and Electric Co. just southwest of Wichita, Kansas. A Foster Wheeler 65,000 sq ft surface condenser of the double-flow type serves the 115,000 kw turbine.

* A fourth FW steam generator, of 800,000 lb per hr capacity is now on order for the Murray Gill Station.



Cross-section of the reheat unit shows arrangement of furnace with space provided for possible future conversion to coal firing.

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

ON MURRAY GILL STATION

Of outdoor design, this 800,000 lb per hr Foster Wheeler reheat steam generator supplements two other FW units of 425,000 and 625,000 lb per hr capacity serving this modern central station.

CUSTOMERS of Kansas Gas and Electric Company are consuming more and more electric power. The greater use of electric appliances in the home, increased commercial business, enlarged industrial production — all are resulting in an ever-growing demand on the company's facilities.

And at the Murray Gill Station, the company's newest and most efficient operation, with a total generating capability of 240,000 kw, three Foster Wheeler steam generators are now helping meet this upward trend.

The third FW unit to be installed at Murray Gill went into service in April of 1956 — 20 months after placing of contract. It has a capacity of 800,000 lb steam per hr with corresponding reheater flow of 692,000 lb per hr and steam outlet conditions of 1005 F/1005 F and 1925 psig at the superheater outlet.

Repeat orders like this represent a positive expression of confidence in Foster Wheeler steam plant equipment. With more than fifty years of experience in steam generation — and the finest modern manufacturing facilities in three large plants — Foster Wheeler welcomes the opportunity to quote on your requirements. *Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.*

Aerial view of Murray Gill Station of KG&E, showing outdoor-type reheat steam generator at left and FW dual circulation units at right.

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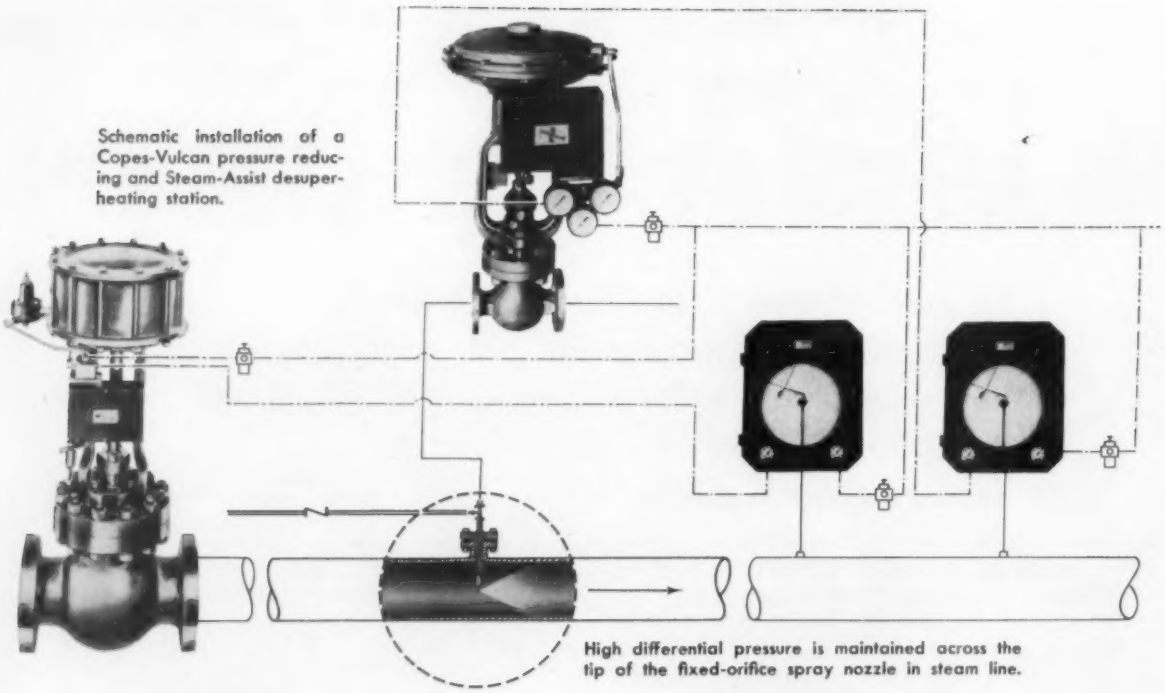
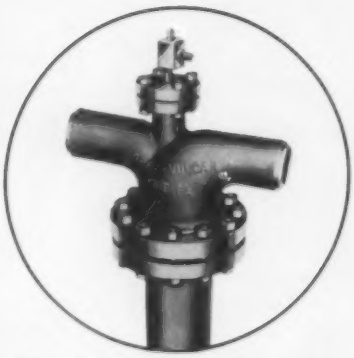


Schematic installation of a Copes-Vulcan pressure reducing and Steam-Assist desuperheating station.

High differential pressure is maintained across the tip of the fixed-orifice spray nozzle in steam line.

NEW Copes-Vulcan Pressure Reducing and Desuperheating Stations



Copes-Vulcan offers in-line or carburetor type Steam-Assist, or simple mechanical-atomizing desuperheaters.

Represented in Canada by: Peacock Brothers Limited, Montreal, Sydney, Toronto, Calgary, Edmonton; W. W. Hicks & Co., Winnipeg.

These high-quality pressure reducing and desuperheating stations offer the latest advances in reducing valves and desuperheaters. They give you an integrated station designed specifically to meet your operating needs.

Copes-Vulcan valves—diaphragm or piston operated, depending on your conditions—give close modulating control. Simplified design means optimum operating characteristics with easy, low-cost maintenance.

The Steam-Assist Desuperheater advances a new principle in reducing steam temperatures. Cooling water and assisting steam are mixed in the exclusive swirl chamber, upstream from the point of injection. No large steam bubbles form to cause hammer or vibration. Flow of assisting steam can be automatically reduced as load increases, and shut off completely at high loads where no more than mechanical atomization is needed.

"Packaged" control systems by Copes-Vulcan mean undivided responsibility, custom design and lifetime engineering service. They assure top performance over an unusually long service life.

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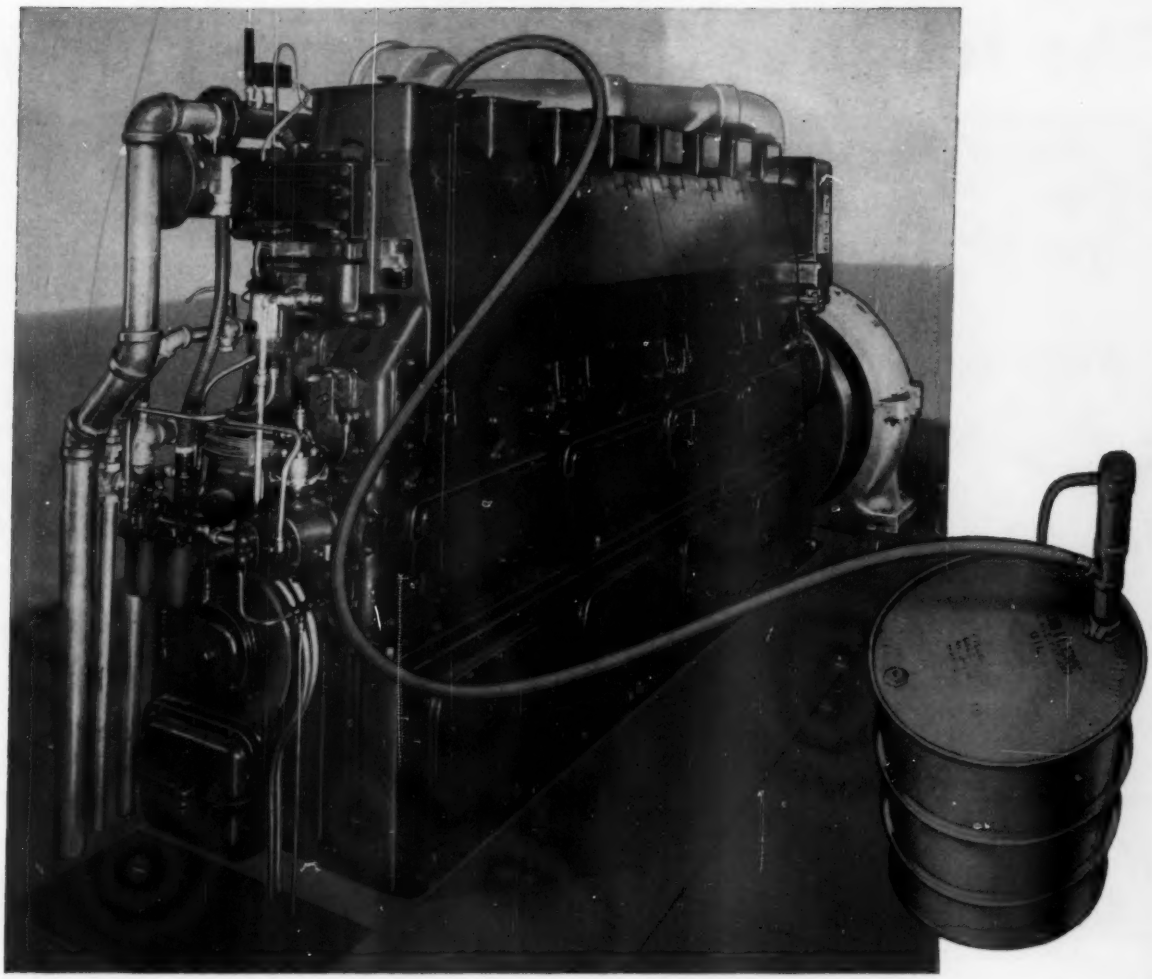

Stops Thin-Out!

You can protect your Diesel against wear due to excessive thin-out of the lubricating oil at higher operating temperatures. Switch to Sinclair RUBILENE®, *the high viscosity index oil* proved by over 35 years in a wide variety of Diesel applications. You'll find RUBILENE holds its high film strength and reduces oil consumption . . . gives you better protection of cylinders, pistons, rings and other vital moving parts operating continuously for long periods. Your Diesel logs more full-power hours!

Switch now to RUBILENE. Regardless of the make of your Diesel, there's a member of Sinclair's famous RUBILENE or RUBILENE HD family that meets your needs exactly! Call your local Sinclair Representative or write for free literature to Sinclair Refining Company, Technical Service Division, 600 Fifth Avenue, New York 20, N. Y. *There's no obligation!*

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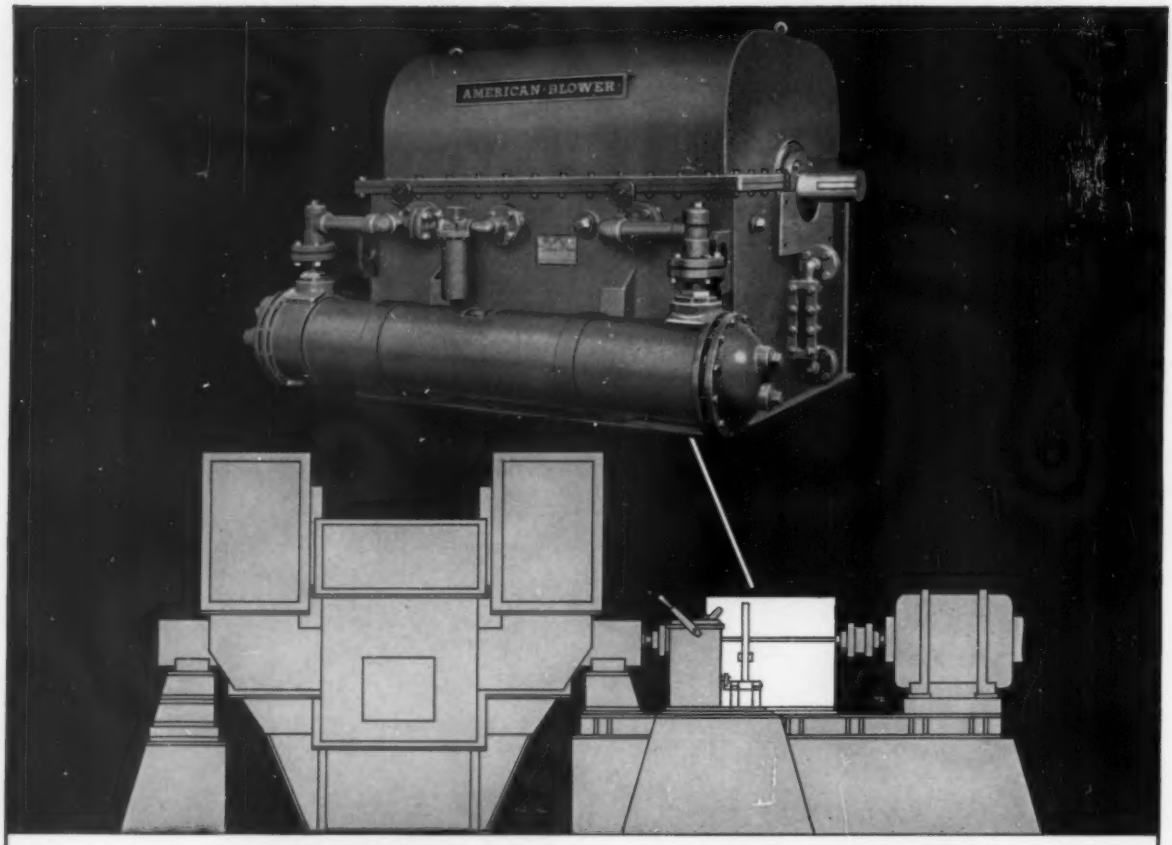
The tougher the duty, the more

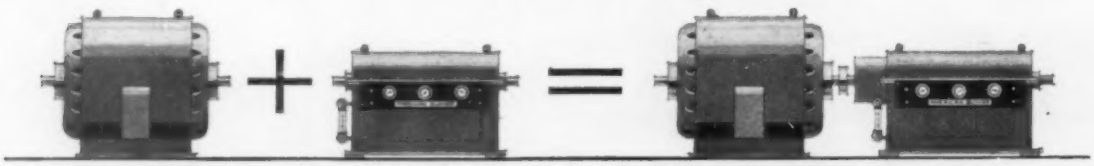


Mechanical Draft Fan Gýrol Fluid Drive Motor

LARGER MECHANICAL DRAFT FANS — Gýrol Fluid Drive gives you the kind of accurate, efficient control of mechanical draft that results in important power savings longer equipment life. The reason: Fluid Drive's infinitely adjustable speed control, which enables each fan to operate at its optimum design or selection point.

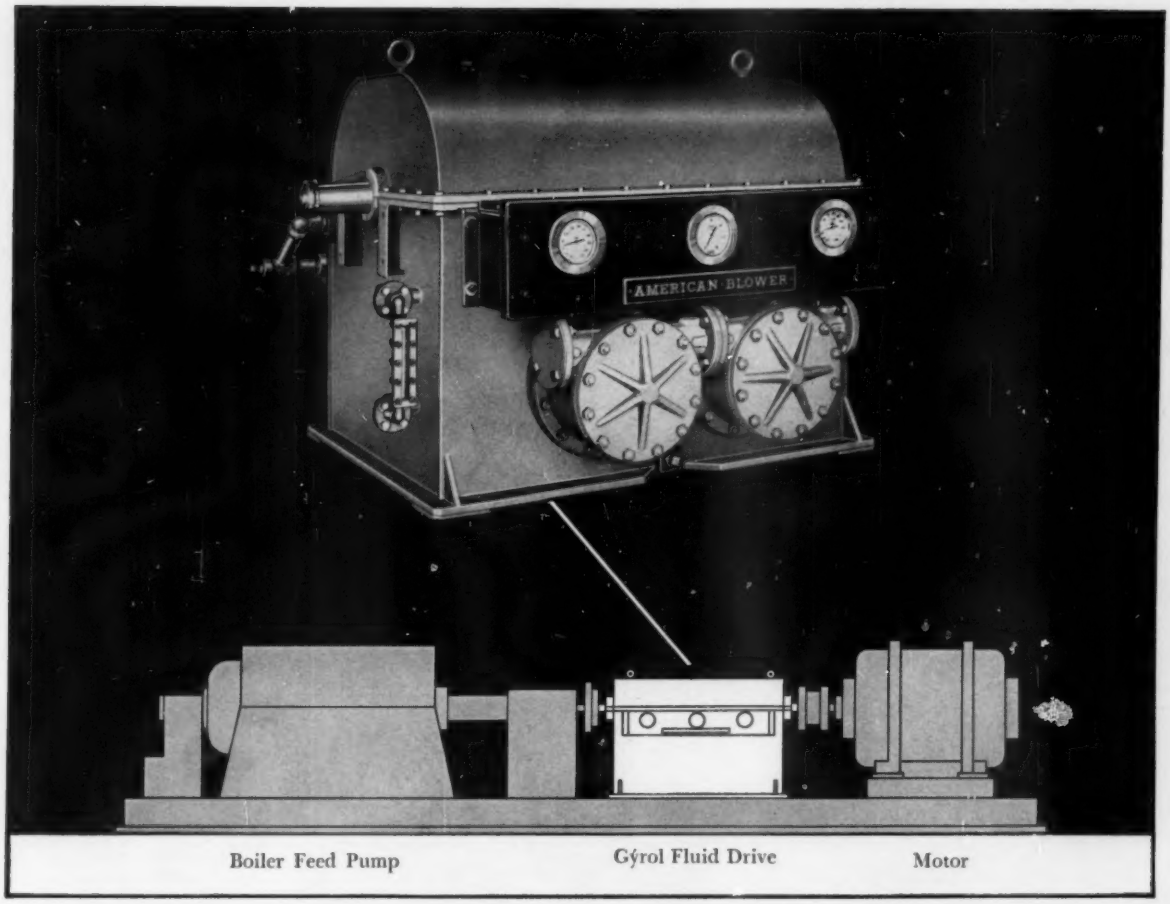
This adjustable-speed feature saves horsepower, gives good, stable volume and pressure control over the operating range . . . simplifies motor-starting equipment . . . reduces damaging high- and long-duration inrush currents on the motors . . . provides no-load starting of high WR^2s that exist in the new, high-volume, high-pressure fan wheels.

What's more, it prolongs life of fan bearings; reduces fly-ash abrasion on fan wheel, fan scroll, inlet boxes, and breeching connections. When you add to these advantages the reduction in noise level, it becomes increasingly clear that the tougher the duty, the more you need Gýrol Fluid Drive for control of mechanical draft.



Rugged constant-speed induction motor American Blower Gýrol Fluid Drive Smooth, adjustable-speed control

you need Gyrol® Fluid Drive



Boiler Feed Pump | Gyrol Fluid Drive | Motor

LARGER BOILER FEED PUMPS — As larger boiler feed pumps are built, there is a greater need for higher efficiencies and more accurate control. That's why more and more consulting and utility engineers are recommending Gyrol Fluid Drive.

You see, Gyrol Fluid Drive offers adjustable-speed pump control that saves power over the entire operating range by eliminating wasteful throttling. Then, too, Fluid Drive reduces wear on bearings and other vital parts by operating the pump at speeds that fit boiler demands. Paralleling of pumps is simplified. And emergency changeover from operating to standby pump is fast and foolproof—there's no need for boiler shutdown.

If your plant expansion calls for boiler feed pump control, it will pay you to talk to an American Blower engineer. He can show you where Gyrol Fluid Drive can save power, cut costs, give you a more efficient operation. Contact our nearest branch office, or write us direct. American Blower Corporation, Detroit 32, Michigan. In Canada: Canadian Sirocco Company, Ltd., Windsor, Ontario.

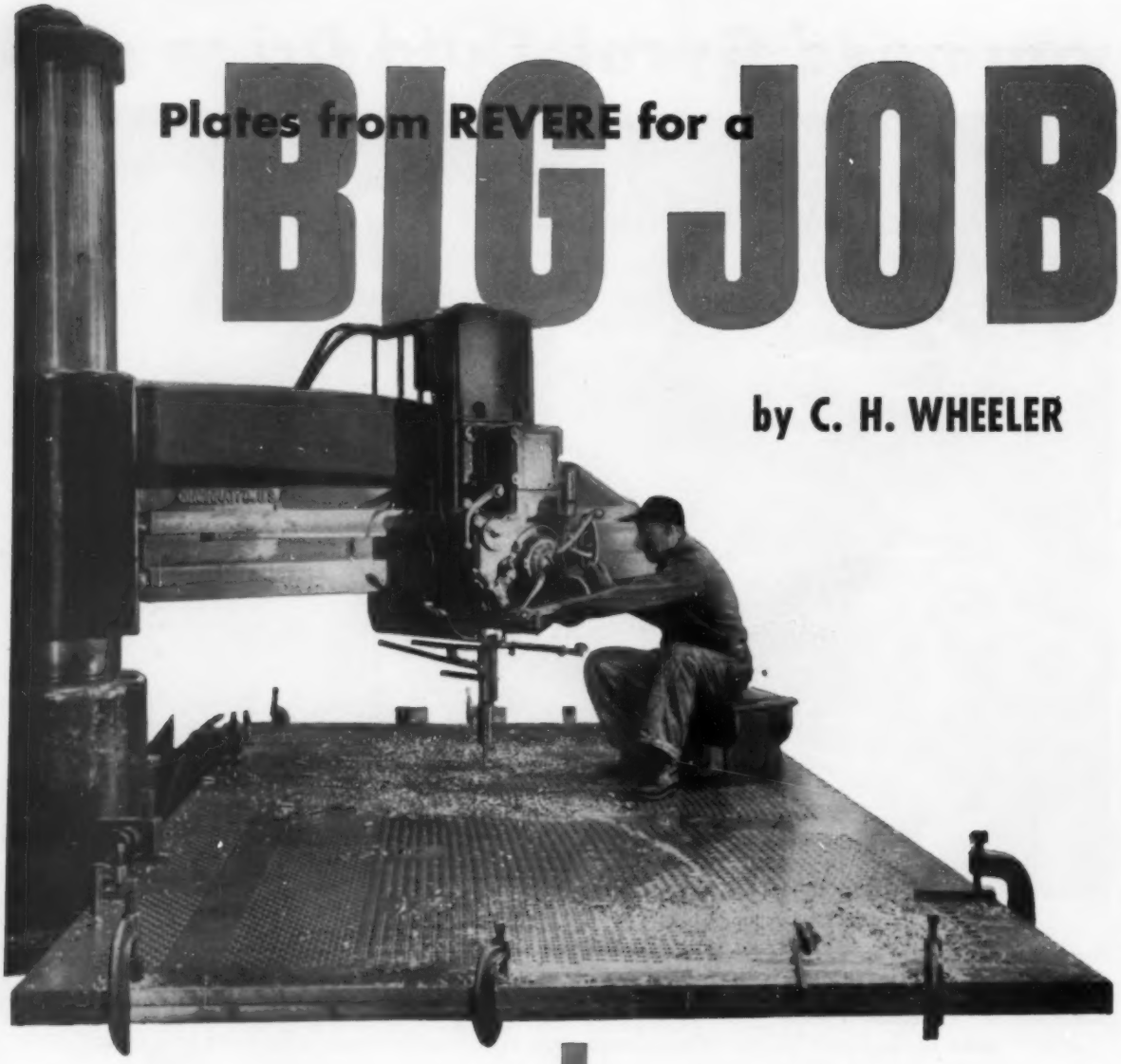
AMERICAN BLOWER

Division of American-Standard

For more data circle 533 on Post Card

Plates from REVERE for a BIG JOB

by C. H. WHEELER



Here you see two rolled Muntz Metal condenser plates, being drilled simultaneously in the plant of the C. H. Wheeler Manufacturing Co., Philadelphia 32, Pa. The plates were supplied by Revere. They measure 100-¾" x 203-¾" x 1-½" thick. Four plates were supplied for a Wheeler 2-pass divided water box unit having 95,000 sq. ft. of condensing surface. The overall length of the condenser, including water boxes, is 48 ft., and overall height, including steam dome and hot well is 34 ft.

Revere is an important supplier of plates and tubes for condensers, heat exchangers, and similar equipment, shipping to all parts of the country. Collaboration on alloy selection and specification is freely available. Just get in touch with the nearest Revere Sales Office.

COPPER ★ BRASS ★ 18 01 ★ REVERE ★ ALUMINUM

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Dowell scientist using the Optical Emission Spectrograph to get an accurate analysis of samples sent in from the field.

On the trail of scale

Analyzing chemical cleaning drain samples to determine how much scale and metal were removed is easy for this laboratory detective. Among the instruments at his disposal is this Optical Emission Spectrograph, capable of tracking down impurities as low as .0001 per cent in certain elements. Instruments like this are in constant use by Dowell scientists in their day to day search for answers to your industrial cleaning problems.

They've got an eye to the future, too. For in this completely equipped and modern laboratory, new methods and treatments are being found to make Dowell chemical cleaning even more effective. Get the full benefit of the Dowell research program. Call your Dowell engineer. He's ready to help you.

chemical cleaning services for industry **DOWELL**

A Service Subsidiary of The Dow Chemical Company
DOWELL INCORPORATED • TULSA 1, OKLAHOMA

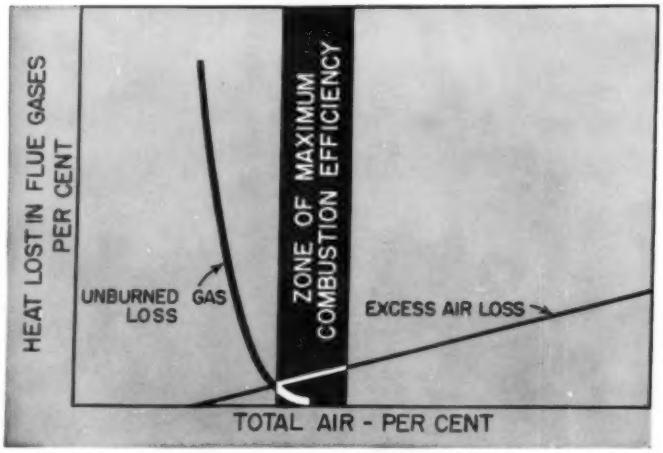
How to get maximum combustion efficiency . . . measure <u>both</u> combustibles and oxygen

Simultaneous measurement of both oxygen and combustibles is needed to obtain optimum combustion. No instrument that measures only one of these two interdependable factors can give you the full information necessary.

Now, Bailey offers two units, each giving a continuous and simultaneous double check on combustion efficiency: a permanent analyzer-recorder which records both factors on a single chart; and a new light weight, portable unit which indicates both factors.

Both instruments measure: (1) excess air—regardless of the fuel or combinations of fuel being burned, (2) mixing efficiency of your fuel burning equipment by showing per cent combustibles in the flue gas.

Both units are designed to increase efficiency in the furnace operations of the steel industry, on glass tanks, cement and lime kilns, ceramic and refractory kilns, steam boilers and also on direct and indirect-fired furnaces in the metal processing industries. To prevent your money from becoming waste gas, look into these two efficiency provers. A Bailey engineer will be glad to give you details or write us for product specifications.


HEAT LOST IN FLUE GASES PER CENT
UNBURNED GAS LOSS
ZONE OF MAXIMUM COMBUSTION EFFICIENCY
EXCESS AIR LOSS
TOTAL AIR - PER CENT

Maximum Combustion Efficiency is secured by keeping the sum of Excess Air Loss and Unburned Gas Loss to a minimum. To do so by the direct method simply measure both oxygen and combustibles in flue gas.

For portable use—
HEAT PROVER Analyzer

The famous Cities Service HEAT PROVER analyzer is now Bailey built and sold. Weighing only 25 pounds, it is a self-contained automatic analyzer including a sampling tip and hose plus a thermocouple for temperature measurement.

Instrument dials are dual range for greater accuracy and sensitivity.

For permanent installation
Oxygen-Combustibles Recorder

The Bailey Oxygen-Combustibles Analyzer-Recorder coordinates both records on one chart. These records enable the operator to keep fuel burning equipment performing continuously in the zone of maximum combustion efficiency. Excess air may be reduced to the point where combustibles begin to show.

G 40-1

Instruments and controls for power and process

BAILEY METER COMPANY

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In Canada—Bailey Meter Company Limited, Montreal

BAILEY METERS

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not just a low delivered price
If it's OLD BEN COAL it's always FRANKLIN COUNTY COAL . . . accessible to Rail-Water transportation.
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EQUIPMENT NEWS

Described on these pages are new and improved products. Use Reader Service Cards on pages 135–136 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—DUAL FIXTURE handles lighting, air conditioning

Called the Multi-Vent Trofferlite, this fixture is designed to diffuse conditioned air and provide illumination and to be adaptable to any drop-type ceiling. Jointly developed by Pyle-National Co. and Benjamin Electric Mfg. Co., the fixture is reported to simplify engineering, make possible cleaner, more attractive interior design, and lower initial cost. It is claimed to actually increase light output and improve the quality of air conditioning, as well as to eliminate dirt smudges on the ceiling. Where minimum cooling is needed, the fixture can remain unattached to the air duct or shut down. A booklet provides sound level charts and selection data on this fixture. Benjamin Electric Mfg. Co.

2—CIRCUIT BREAKER for fast tripping, interruption

Type FB-12 High Speed D-C Circuit Breaker is announced as operable at 1000 v and 1200 amp continuous. Its primary applications will be for protection of generators, and traction or driving motors; also for feeder breakers and, in multiple pole assemblies, for anode protection. The FB-12 is designed for extremely fast tripping and interruption of fault currents — to interrupt in a total of 0.012 sec, and limit current magnitude in 0.004 sec. Breaker can be set for high speed tripping on either forward or reverse current, is built in single and multiple pole assemblies, each with its own individual closing motor, this breaker can be wired for individual pole reclosing or for automatic reclosing. I-T-E Circuit Breaker Co.

3—VALVE WARMER aids in holding proper flow temperature

Applicable to a wide range of valve designs from 4- to 10-in. sizes, this clamp-on type valve warmer is made of two sheets of metal. The outside sheet is embossed to create flow channels. The inside sheet is flat. The two sheets are welded together and then curved to fit the valve. Since the inside sheet is flat it makes close heat transmitting contact with the valve to afford good heat transfer for wax, asphalt, petroleum, glycerine. Called the Thermo-Panel Coil Valve Warmer, this unit is said to be easily put in place, or removed, and to be lighter in weight more compact, and lower in cost than many valve warming devices. Dean Products, Inc.

4—DESUPERHEATER is designed for the tougher jobs

The C-V Steam-Assist Desuperheater is claimed to meet specifications for a conventional steam atomizing type — and yet normally use assisting steam on light loads where control is most difficult. A stainless steel swirl chamber with no moving parts serves to automatically reduce flow of assisting steam as load increases and shut off completely at high loads where mechanical atomization alone is effective. The new desuperheater is designed to control reduced steam temperature at loads from 15 to 100 per cent of maximum and give close control down to 10 deg above saturated temperature. For in-line installation, unit vaporizes cooling water. Permanent pressure loss is claimed negligible.

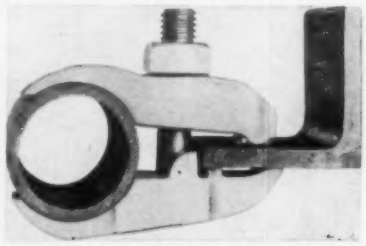
According to requirements, the temperature controller may be either indicating or recording and can be provided with straight proportional, proportional plus reset or proportional plus reset plus derivative responses. Desuperheater is designed for use with any pipe line size, pressure or initial steam temperature. Copes-Vulcan Div., Blaw-Knox Co.

5—FEED PUMP for applications of 7 gph or less

Model 4411 is described as a compact and simplified chemical feed pump with a maximum capacity of 7 gph/feed and discharge pressures to 600 psi. Of the positive displacement plunger type, this pump contains built-in operational features of company's larger capacity feed pumps, such as "capsulated" construction. The pump is suggested for applications requiring precision and economy in the continuous feeding of chemicals used in water conditioning, chemical process additive feeding, petroleum inhibitor addition. Hills-McCanna Co.

6—PIPE, CONDUIT CLAMP has double bite

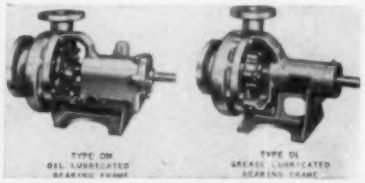
The Latrobe Clamp is made of iron, cadmium plated to prevent rust, and has double bite of case hardened tool steel. The safety bite is V-shape to give a



double bite into the steel frame to which it is attached. Attachment may be made without drilling holes in the frame work. It is made in two models: one for right angle support and one for parallel support (illustrated), and comes in ten sizes for pipe or conduit from ½ to 4 in. Fullman Mfg. Co.

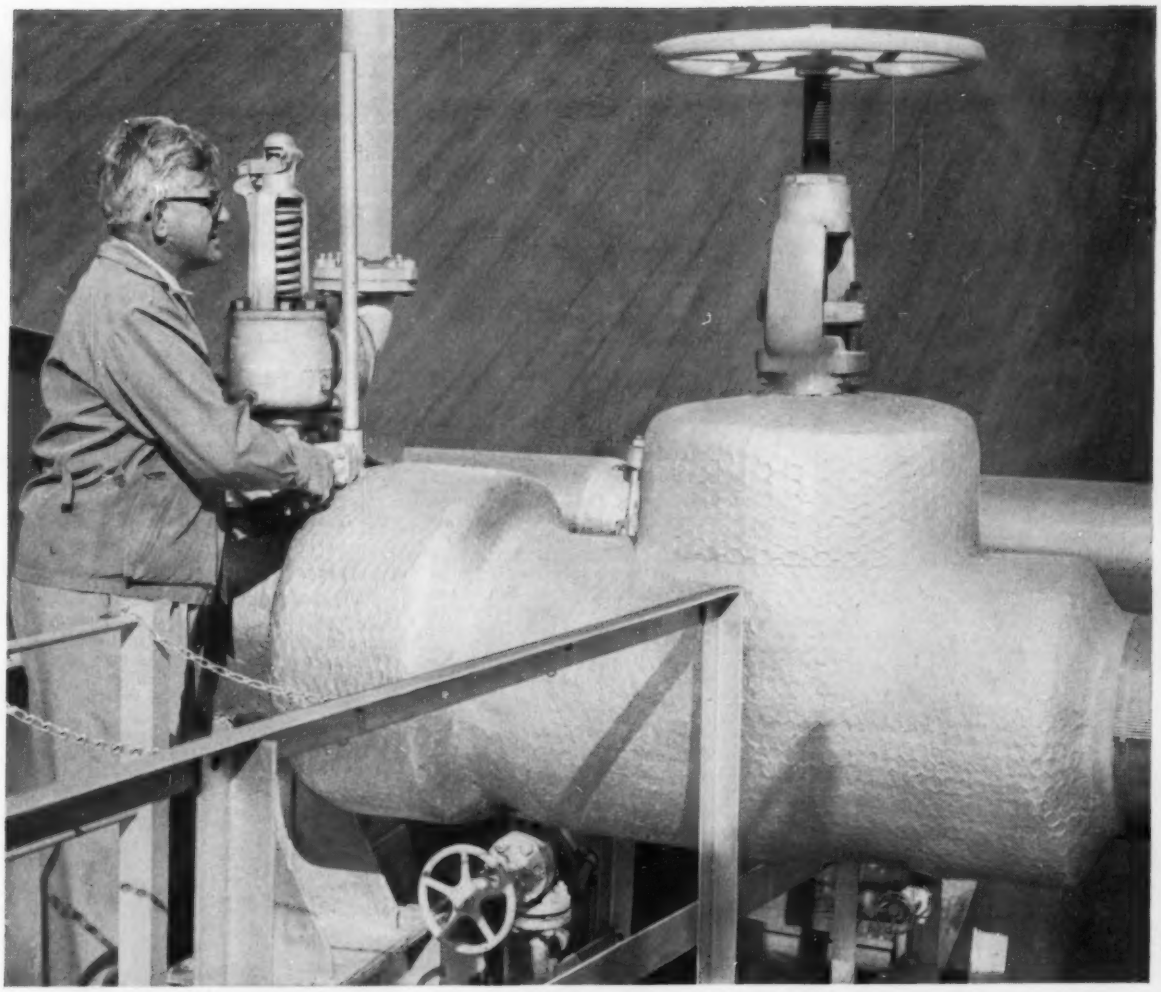
7—PROCESS PUMPS handle many liquids, hot or cold

For pumping most all chemical process liquids, either hot or cold, in moderate capacities against low, medium or high heads, with emphasis on interchangeability of pump components, this manufacturer introduces the Types DL and



DM Pumps. They are available in discharge sizes from 1 through 4 in., in capacities to 800 gpm. Enclosed or open impeller design is optional construction. The pumps will operate against heads to 400 ft. Driver can be a standard, horizontal, electric motor mounted on common base with pump.

There are two basic designs — the grease-lubricated Type DL and the oil-lubricated Type DM. Standard bearing construction for operation at temperatures to 250 F is grease lubricated. Above 250 F to 400 F oil lubricated construction is utilized. The latter construction is also available for pumps handling liquids to 250 F. An important feature



This Crane valve has 20-year cost-free record on 400 psi. steam at 750° F.

Twenty years on this high-temperature steam boiler outlet service with never a wrench on it—that's valve performance in any man's language.

This Crane 8-inch No. 179U cast steel stop-check valve has racked up just such a record at Fort Bend Utilities Co., Sugar Land, Texas, and is working as smoothly today as it did two decades ago.

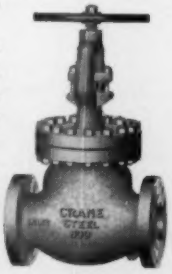
The Fort Bend Utilities plant—a subsidiary of the neighboring Imperial Sugar Co.—finds this Crane stop-check an important aid to boiler efficiency.

Its high-lift disc permits maximum flow-through, with minimum pressure drop under varying load conditions. Seating is instantaneous on back flow.

On manual closure, about once yearly for boiler servicing, the valve has never failed to respond smoothly and seat tightly.

To valve users experienced with Crane quality, this performance record is not so unusual. Thousands of Crane stop-checks throughout industry are giving similarly outstanding service.

The superior materials, the top-flight engineering and construction designed into all Crane valves give them service capacity and durability second to none.



Get these advantages next time you order valves: specify Crane and be *certain* of the valve service you want. Consult your local Crane Representative or write to address below.

CRANE VALVES & FITTINGS

PIPE • KITCHENS • PLUMBING • HEATING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

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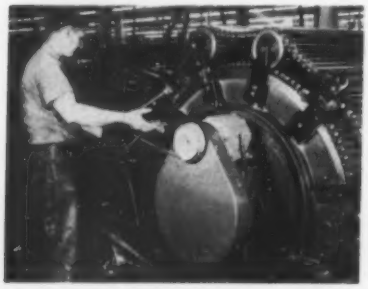
of this pump line is economy achieved through interchangeability of components, it is noted. To either the Type DL or Type DM frame, you simply add the desired back plate (air or water cooled), the desired impeller, and the proper volute case to build the "proper" pump. These pumps are detailed in Bulletin B-1608. Peerless Pump Div., Food Machinery and Chemical Corp.

8—CARD DRIVE for textile mill applications

This improved card drive is designed to solve the textile mill's problem of giving a soft start to the heavy inertia card mechanism. Built around Flexidyne, manufacturer's dry fluid drive announced last year, this drive is claimed to enable a smooth start to a card having a heavy inertia load, and to accelerate



the card to full running speed within 30 sec without excessive strain on either motor or card. Besides giving the card a soft start, the Flexidyne is said to protect against excessive current draw during the starting period, to eliminate need for expensive controls, and permit use of a normal rather than a high-torque motor. It can also be run in reverse for stripping the card.

The new product consists of a Flexidyne keyed to the motor shaft, a pedestal supporting the motor on which the Flexidyne is mounted, a V-flat drive from the Flexidyne to the card shaft, an aluminum stripper pulley on the outer end of the Flexidyne housing, and an aluminum guard covering drive and V-belts. The whole is package unit which can be installed readily. Three grooves are cut in the driven hub of the Flexidyne for three steel cable belts which transmit power to a straight-faced pulley mounted on the card shaft by a Taper-Lock bushing. The pedestal has an adjustable motor base to control V-belt tension. Dodge Mfg. Corp.

10—CURRENT LIMITING FUSE is ribbon element type

Type EJ-2 Ribbon Element Current Limiting Fuse for motor starter application consists of silver elements surrounded by dry inorganic quartz sand. The new fuse, which supersedes a wire element fuse, is enclosed in a strong insulating tube, and connected to the circuit by means of copper ferrules on each end of the tube. A higher continuous current rating is available with the new unit. Although designed to fit into the mountings of the wire element fuse, the new fuse is smaller and more compact than its predecessor. It generally requires only a single tube, company points out, whereas the ratings of many wire element fuses require double tubes. General Electric Co.

11—VARIABLE SPEED DRIVE with interchangeable components

Called Vari-Mount, these variable speed drives feature standard, interchangeable components and are designed to accommodate standard motors. Capacities range from one to 15 hp with maximum speeds from 355 to 2.5 rpm. Speed adjustment ranges are available up to 6:1. By using company's standard Line-O-Power reducers and various standard motor speeds, units can be individually tailored to produce almost any desired speed, power and reduction ratio. Vari-Mount is available in vertical or horizontal models and can be operated by remote or manual control. Foote Bros. Gear and Machine Corp.

12—PRESSURE REDUCING VALVE, relief valve, combined

The No. 385-Type F is announced as a combination pressure reducing and relief valve for air, gas, oil or water service that operates on initial pressures to 4000 psi, and features adjustable control pressures that can vary up or down by as little as 2 psi over a range as wide as 0–2500 psi. It is single seated, spring loaded and diaphragm actuated, and is easily adjusted to required reducing and relief settings. This valve has no external actuating connections and is constructed without a stuffing box. It requires little maintenance. It is machined for convenient installation directly in the pipe line. Body construction is of stainless steel; trim is bronze monel. Oil resisting Neoprene diaphragm is faced with Teflon. Bulletin F-56 gives further details. Atlas Valve Co.

9—TANK LIFTER is economical, hydraulically operated unit

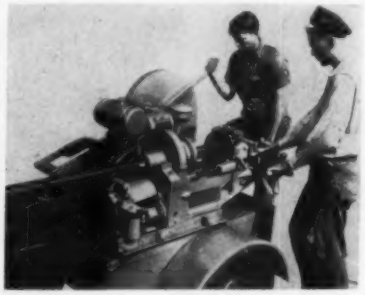
Designed to substantially reduce time and labor involved in raising and lowering oil-filled tanks of frame-mounted, outdoor oil circuit breakers, this tank lifter consists of two cylinders containing pistons and a length of flexible hose with quick disconnect couplings. This lifter is designed for use with manufacturer's own line of circuit breakers (although declared capable of lifting a larger load than required of it) and can be operated directly from the Pneu-Draulic operator of the breaker, or from a portable battery powered pump, as illustrated. When operated from the breaker it connects to the breaker's hydraulic system through a small door in the side of the breaker cabinet. From this vantage point it is claimed possible to have an unobstructed view at all times. Two manually operated needle valves are used to control the raising and lowering of the tanks. Allis-Chalmers Mfg. Co.

13—PIPE MARKERS for a uniform identification system

Power engineers can standardize the pipe identification system for their entire plant self-sticking Perma-Code Pipe Markers. With pipe marking standardized, tracing pipe lines is quick and sure, it is pointed out, also maintenance down time is reduced and plant safety improved. In stock heights to fit any size pipe, these markers are made of all-temperature vinyl cloth with a heavy-duty adhesive and are silicone-plastic overcoated. Company says they are guaranteed to stick to pipes for a minimum of 2 yr. Bold black letters on ASA Standard A-13 background colors identify pipe contents with both color and legend, and matching stock directional arrows indicate flow direction of pipe contents. The markers are mounted on dispenser cards with a fast-release feature to allow for quick application. A planning kit — including a planning guide, cost and safety information, testing samples and stock list — is offered without charge. W. H. Brady Co.

14—PIPE TOOL UNIT can be hauled to the work site

Called the Pipe Shop on Wheels, this unit combines an abrasive cutting machine and a pipe and bolt machine on a pneumatic-tired trailer. It can be hauled by car, truck or jeep and it has plenty



of accessory storage, says manufacturer. The abrasive cutting head is powered with a 8.3 hp Wisconsin gas engine or with a 5-, 7½- or 10-hp 220/440-v 60-cycle, three-phase motor. The pipe and bolt machine is powered with a 110- or 220-v Universal single-phase 25- to 60-cycle motor or a 2500-w d-c generator with extra outlets for small electric tools. The cutting machine has a cutting capacity up to 6-in. pipe or shapes; 2½-in. solid stock. The pipe and bolt machine has a capacity from ⅛- to 2-in. pipe; ¼- to 2-in. bolts — up to 12 in. with a drive shaft which operates geared pipe cutters and threaders. Wheel speed is 2400 rpm. Beaver Pipe Tools, Inc.

15—CHLORINE DETECTOR is highly sensitive instrument

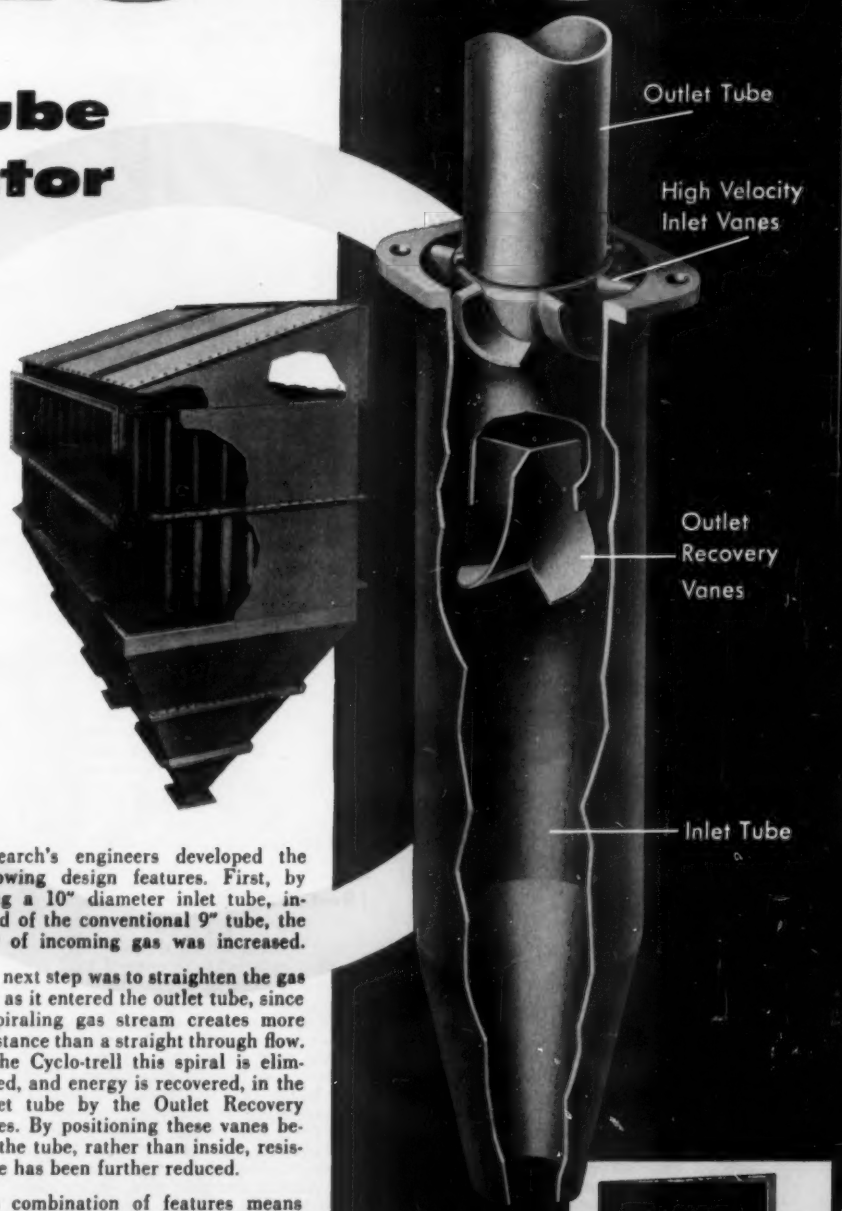
The Solvay Chlorine Detector — an instrument for detecting as low as 3 ppm chlorine gas in the atmosphere — monitors a continuous controlled sample of air, it is announced, warning when chlorine concentrations in the air exceed 3 ppm. Thus, says company, the sensitivity of the detector allows unit to give a warning of the presence of chlorine in the air long before a concentration of 15 ppm is present that would cause throat irritation. The chlorine

NEW Cyclo-trell

multiple tube dust collector

Here are a few brief facts on Research's new multiple tube mechanical collector.

- Collection efficiencies are higher, for a given pressure drop, than other conventional multiple tube collectors.
- Gas flow per tube is higher than conventional units. This means fewer tubes per collector and lower total cost for a given capacity.
- Cyclo-trell's design is based on Research's 45 years experience in manufacturing gas cleaning equipment. As the largest manufacturer of electrical precipitators in the world, Research-Cottrell has engineered and built many combination units consisting of precipitators and mechanical collectors.



Higher Collection Efficiency

An important reason for Cyclo-trell's higher collection efficiency is the aerodynamically shaped inlet vane unit. The purpose of these vanes is to produce a fast spiral of incoming gas. The faster these gases spin, the greater the centrifugal force on the suspended dust.

After testing many types and curvatures of vanes, Research found that this new design resulted in less turbulence, greater centrifugal force and higher collection efficiencies.

Greater Gas Handling Capacity

To develop a higher gas flow capacity than other multiple tube collectors, Research's engineers developed the following design features. First, by using a 10" diameter inlet tube, instead of the conventional 9" tube, the flow of incoming gas was increased.

The next step was to straighten the gas flow as it entered the outlet tube, since a spiraling gas stream creates more resistance than a straight through flow. In the Cyclo-trell this spiral is eliminated, and energy is recovered, in the outlet tube by the Outlet Recovery Vanes. By positioning these vanes below the tube, rather than inside, resistance has been further reduced.

This combination of features means greater gas flow per tube, fewer tubes per collector and a lower total cost for a given capacity and efficiency.

Bulletin M gives complete details on design features, efficiency, capacity and detailed dimensional drawings. Write for your copy today.

Research-Cottrell, Inc.

Main Office and Plant: Bound Brook, N. J. • 405 Lexington Ave., New York 17, N. Y. • Grant Bldg., Pittsburgh 19, Pa. • 228 N. La Salle St., Chicago 1, Ill. • 111 Sutter Bldg., San Francisco 4, Cal.

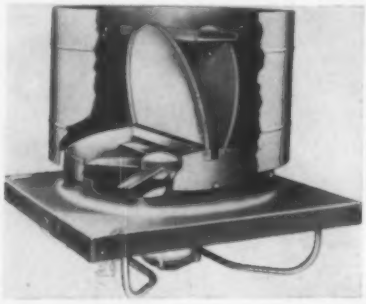
detector is electrically operated with alarm signal resulting from reaction of chlorine gas with a chemically treated dry paper. The unit is made for either wall or panel mounting, and can be used wherever chlorine gas is used or stored. Catalog 50.118 gives details. (The instrument is manufactured under patent license from Solvay Process Div., Allied Chemical and Dye Corp.). Wallace & Tiernan Inc.

16—TELEMETERING SYSTEM does computing jobs, too

This system of telemetering instruments is designed to totalize several flow measurements, correct for such factors as temperature, pressure, specific gravity and supercompressibility in fluids, and provide a corrected flow value. Manufacturer says this system of telemetering transmitters and receivers and electronic self-balancing instruments can be used wherever corrected flow values are vital for proper operation. The instruments can also be supplied in types to perform averaging, totalizing, multiplying and dividing computations involving the basic measured variables listed above. In addition, systems which will extract square root values, obtain the square of the reading or compensate for a particular mathematical law can be supplied, according to manufacturer. The Bristol Co.

17—ROOF VENTILATOR has fire-fighting function, too

Fresh air and fire-fighting, too, highlight the story of Jet Axial Industrial Roof Ventilator, it is announced. Airfoil blades welded to a specially designed hub assure maximum exhaust of heat, smoke, dust and fumes at low rpm's, according to company, offering more working comfort at a smaller consumption

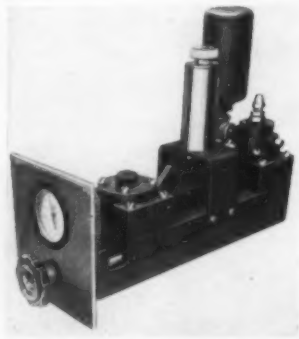


of electrical power output and a minimum of noise. Ventilators can be furnished with a fusible link device which acts as an emergency damper opener during fires.

According to company, fires in one-story buildings spread rapidly unless heat, fumes and smoke trapped close to floor are vented to permit access to area by fire-fighters. Normally, the fusible link keeps dampers closed by spring tension when ventilator is not in use. Exposed to intense heat, the link breaks, allowing dampers to open and smoke and heat to escape. Safety-vent device is independent of fan operation, company states, and spring itself is shielded from flames by damper blades. Butterfly dampers are designed to open automatically during fan operation but weather-seal ventilator during non-use. During operation, exhaust is dissipated with sufficient velocity to exclude rain or snow. Eight sizes are available, with blade diameters from 24 to 60 in., and exhaust capability ranges from 6640 to 53,700 cfm. Detroit Blower Co.

18—RATIO RELAY for pneumatic control applications

Model 3-15 Ratio Relay is designed to produce a true linear change in pneumatic output signal when using "suppressed" ranges such as 3–15 psi, and to give the operator a device for adjusting ratio between input and output signals in control systems such as fuel to



air in combustion processes, feeding of chemicals. According to company, this relay features true rationing around 3 psig input and output bias pressures using a convenient handwheel for changing the ratio; a precision fulcrum drive assures exact ratio adjustment. The relay is compatible with any pneumatic signal system having a range of pressures between 0 and 20 psi.

Another feature announced for the relay is a simple method of altering suppressed scale setting when and if desired. Although primarily for use with the 3-15 psi signals, an adjustment permits changing minimum input and output bias values to any point between zero and 6 psig. Maximum input and output signals may be at any value up to 20 psig. Although compact, the instrument has a valve to permit high air handling capacity. Specification Sheet SP-4315 gives further data. Hagan Corp.

19—CONTROL for automatic rotary register burners

Fireye System FP-2, Model 1012 is announced as a primary control that programs and safeguards the entire operating sequence of fully-automatic rotary register oil and gas burners. It uses two flame-sensitive scanners — one to monitor the pilot flame and supervise light-off sequence, the other to safeguard the main flame. This arrangement is designed to provide additional safety against off-ratio firing. According to manufacturer, programming sequence offered in this system was especially developed for rotary register burners. To assure adequate air flow through the furnace for purging, air dampers or louvers are driven toward the open position for 15 sec, then back to the light-off position prior to each light-off.

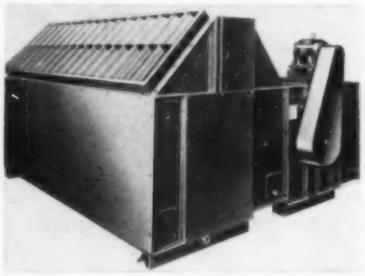
As another feature, the modulator switching circuit accommodates any line, low-voltage or pneumatic firing-rote control system. During normal operating procedure, this control provides for pre-purge, pilot proving limited trial-for-ignition of main fuel and post-purge periods, it is explained; if a flame failure occurs during start-up or operating periods, fuel is shut off within a second. Bulletin CP-32 gives details on this. Electronics Corp. of America.

20—GATE VALVES feature cylindrical construction

These 125-lb bronze gate valves for steam, water, oil or gas, are available in screwed, solder joint and brazing socket ends, in sizes from ¼ through 3 in. Accelerated-wear tests are reported to show that the cylindrical construction results in more than 10 times longer leakproof operating life than many types of valves. Other features include pistol-grip handweel combining a firm, easy three-way grip; an improved impregnated plastic packing material selected because it maintains resiliency and resists leakage longer; heavy pipe-end hexes; extra weight for durability. Circular 564 gives more information. Kennedy Valve Mfg. Co.

21—CENTRAL AIR CONDITIONER serves up to 25 zones

The Multi-Zone Climate Changer is introduced for buildings where one or more zones call for maximum cooling while others require lesser degrees of cooling, and still others, heating. This redesigned unit was created to perform the following functions: Supply any combination desired . . . complete air conditioning, cooling only, heating only,



cooling and ventilating, heating and humidification, etc. Furnish conditioned air to as many as 25 zones with temperatures which can be varied to individual zone requirements. Eliminate need for reheat coils and their separate controls in ducts leading to individual zones. Allow for job-site zoning flexibility. Provide advantage of using just one source of either chilled water or refrigerant.

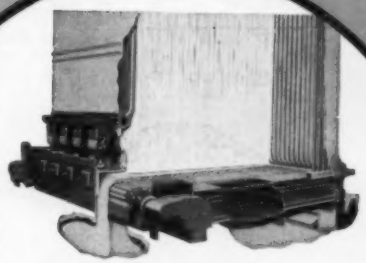
These air conditioners come in nine sizes with capacities of 1700 to 29000 cfm of air. They can use any type of cooling and heating coil including chilled water, direct expansion refrigerant, steam or hot water. Bulletin DS-303M gives further details. The Trane Co.

22—ELECTRICAL SPAGHETTI has many applications

Kelon-T (Teflon) Electrical Spaghetti Sleeving Insulation combines excellent electrical and mechanical properties, manufacturer announces, is unaffected by a wide range of ambient temperatures, pressure altitude and humidity, and resists moisture, abrasion, and cor-

USE DETROIT SPREADER STOKERS TO BURN SOLID FUELS WITHOUT EXPENSIVE PREPARATION

DETROIT ROTOGRATE • ROTOSTOKER • ROTOSTOKER (TYPE C-C)
HIGH ECONOMY AND AVAILABILITY • LOW MAINTENANCE



1

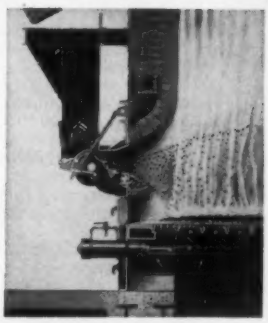
DETROIT ROTOGRATE

Original spreader stoker with forward moving grates that discharge the ash at the front. Our long experience has contributed to many exclusive refinements and features of design. Proven superiority with hundreds installed here and abroad. For capacities up to approximately 400,000 pounds of steam per hour.

Detroit Stokers burn any Bituminous Coal or Lignite without special preparation. Commercial sizes ranging from 3/8" x 0" to 1¼" x 0" are ordinarily used. High burning rates without clinkering difficulties. Also many refuse fuels including wet bark, hogged wood, bagasse, etc. are burned separately or in combination with coal; efficiently and without smoke.

Widely fluctuating loads are easily handled. Parasite power is negligible. High overall efficiencies at all capacities are assured. Maximum availability and very low maintenance.

Buy "Detroit"—They are "the most".



2

DETROIT ROTOSTOKER

For small and medium size units. Power Dumping, Hand Dumping or Stationary grates to fit the furnace provide desired capacity under full automatic control.

3

DETROIT ROTOSTOKER (TYPE C-C)

Continuous cleaning type particularly suited to highly fluctuating loads. Many sizes for capacities of 5,000 to 75,000 pounds of steam per hour. Reciprocating grates discharge ash at front. No basement is required.

DETROIT STOKER COMPANY

GENERAL MOTORS BUILDING, DETROIT 2, MICHIGAN

Works at Monroe, Michigan: District Offices in Principal Cities

WRITE FOR BULLETINS ON THESE MONEY SAVING STOKERS

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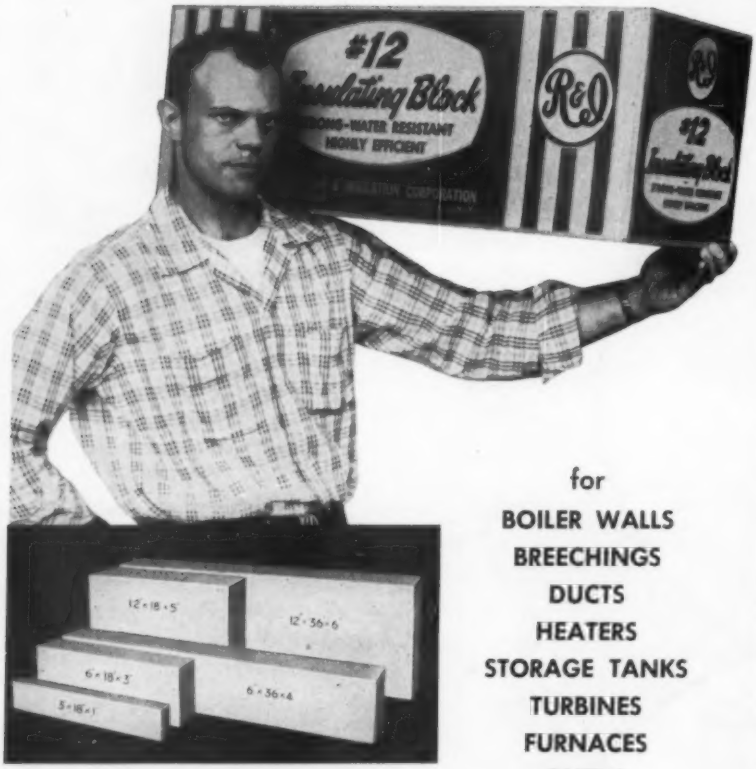
It's Lighter
It's Stronger



for
BOILER WALLS
BREECHINGS
DUCTS
HEATERS
STORAGE TANKS
TURBINES
FURNACES
OVENS

- *Lightweight* • *White*
- *Strong* • *Rigid*
- *Clean sharp edges*
- *Coated—little or no dust*
- *Unaffected by steam or water*
- *High insulating efficiency*

R & I #12 Block applied to refractory tile of boiler wall.

Available in thickness from ½" to 12" and sizes from 3" x 18" to 12" x 36". Prompt delivery.

REFRACTORY & INSULATION CORP.
REFRACTORY BONDING AND CASTABLE CEMENTS
INSULATING BLOCK, BLANKETS AND CEMENTS
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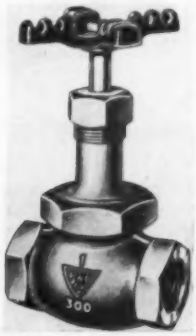
For more data circle 542 on Post Card

rosive chemicals at high and low temperatures. According to company, it remains serviceable at temperatures from −90 to 250 C, has good dielectric constant, and constant power factor over an extremely wide frequency range. Since it is heat resistant, company notes, spaghetti allows assembly by modern soldering techniques. Applications include sheathing for hook-up wire insulation for solder junctions and terminals, in electronic components, and in instrument tubing. It is available in standard colors in cut lengths or on spools and in sizes from No. 26 to 8 and larger. Shamban Engineering Co.

23—BRONZE GLOBE VALVE of heavy duty construction

Fig. 427-DP is a bronze globe valve for industrial steam, water, oil and gas service where continuous control or regulation of control is required. Manufacturer claims that it is particularly effective for frequent or continuous



throttling and other severe applications. Its stainless steel disc and seat ring is of 500 Brinnell and/or Rockwell C-52 hardness to resist wire-drawing by high velocity currents and abrasion by gritty particles. Of full-plug construction for closer regulation and longer life, it is rated for 300 lb steam at 550 F maximum — 1000 lb OWG in ¼- to 2-in. sizes; 600 lb OWG in the 2½- and 3-in. sizes. Construction features include a union bonnet. R-P & C Valve Div., American Chain & Cable Co., Inc.

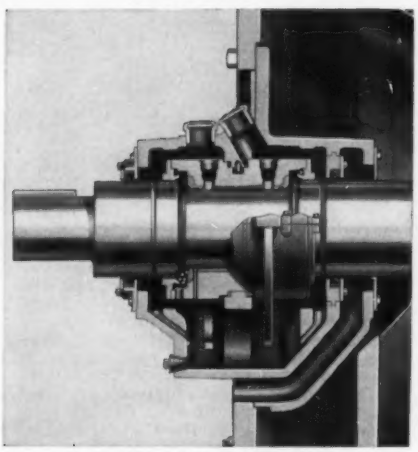
Reader Service Cards on pages 135–136 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

24—PNEUMATIC CONTROLLER with high stability of control

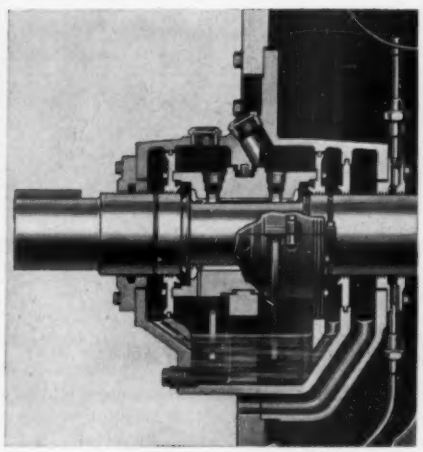
Series 500 Air Controller features high stability of control action without loss of sensitivity, manufacturer announces. It is offered for measuring and controlling such variables as pressure, vacuum, temperature, liquid level, flow, differential pressure, and mechanical motion. Control modes available include narrow band (on-off), proportional, reset, derivative, and reset plus derivative. Cascade, selective, and ratio control models are

NEW Bearing Design Means Better Motor Performance

Allis-Chalmers capsule-type sleeve bearings now perfected for complete motor line



Standard capsule-type sleeve bearing



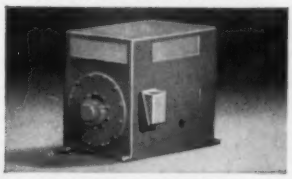
High speed capsule-type sleeve bearing

A new feature—an improved capsule-type bearing design—has been added to the Allis-Chalmers complete line of large end-shield bearing motors. This new bearing will give you better motor service, simplified maintenance and longer motor life through features like:

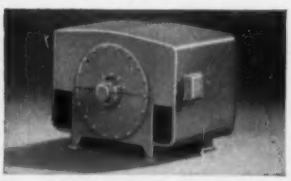
- Dust-tight, leakproof enclosure protects bearing from dirt, dust or abrasive materials.
- Venting system prevents oil leakage — keeps oil and vapor from getting into motor enclosure.
- Dual oil-rings insure bearing surface lubrication — either ring can adequately lubricate bearing.
- Split end-shield gives easy accessibility to winding and air gap — without disturbing capsule or bearing alignment.

Drip-proof or splash-proof cage motor

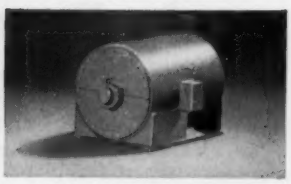
Synchronous or wound-rotor motor



High speed cage motor

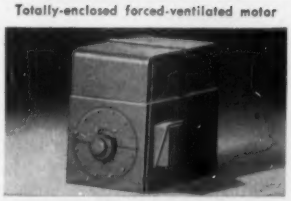


Weather-protected motor



Totally-enclosed fan-cooled motor

Totally-enclosed forced-ventilated motor



Water-cooled or inert-gas-filled motor

Capsule-type bearings are standard on these Allis-Chalmers motors.

You get MORE from Allis-Chalmers motors

More design and construction features — more application help. For complete information, contact your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-5032

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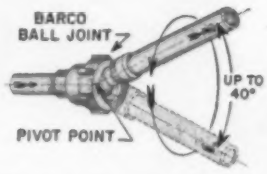
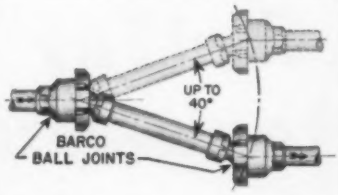
How Barco Ball Joints Solve Piping Flexibility Problems

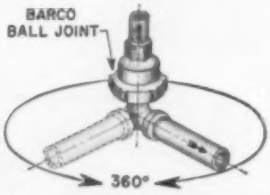
FOR TEMPERATURES UP TO 1000° TO 1200°F.



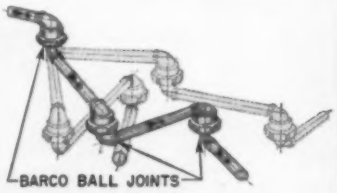
ONE JOINT—Provides for angular motion or positioning of piping in any plane. (Also see below.)



TWO JOINTS—This arrangement provides for piping alignment or simple flexible connection.



ONE JOINT—Allows for full 360° swivel or swing motion, in addition to angular movement shown above.



THREE (OR MORE) JOINTS—For complete flexibility. Any angle! Any radius! Any plane! Many arrangements possible.

In Power, Process, and Heating Service

CERTAIN distinctive characteristics and features make Barco Flexible Ball Joints particularly well-suited for solving many present-day power plant piping design problems, especially for *Steam Service:*

1. **Ability to handle compound movement (where twisting is combined with thermal expansion and contraction).**
2. **Virtually no deterioration. Able to stay in service for years without repairs or maintenance. No lubrication.**
3. **No heavy pipe anchoring required. No "end thrust" developed under pressure.**
4. **Maximum safety for high temperature applications. All-metal construction. Special metals can be specified.**
5. **Basic design is pressure sealing against leakage and self-adjusting for wear.**
6. **Easy to engineer joints into piping to provide for any degree of flexibility, expansion, or movement required.**

GET THE FACTS— New Catalog 2158 is an interesting, illustrated handbook on the application of Barco Flexible Ball Joints. Send for your copy NOW.

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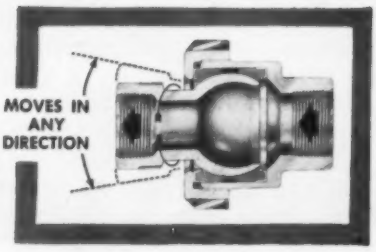


For more data circle 544 on Post Card

also available, as well as program control models. Among design features noted are wide proportional band width (½ to 400 per cent) with easy shift in width, full zero derivative setting on triple mode controller, reset action stops for prolonged deviation from set point under severe load changes. Bulletin A130 gives more details. The Bristol Co.

25—REMOTE ALARM gives out with a loud blast

This automatic remote alarm system offers both audible and visible warning for abnormal process functions. The system works over a two-wire pair or single wire and ground return up to several miles, it is noted, and the alarm produces a blast audible for more than

2500 ft. According to manufacturer, any condition that will operate a switch or relay will trigger the alarm. Complete alarm systems are available with standard sensing devices for: altitude, high or low pressure, temperature and flow, electrical and physical load, intrusion or position. The basic alarm unit is also available for integration in other control or alarm system. Sparton Control Systems Div., The Sparks-Withington Co.

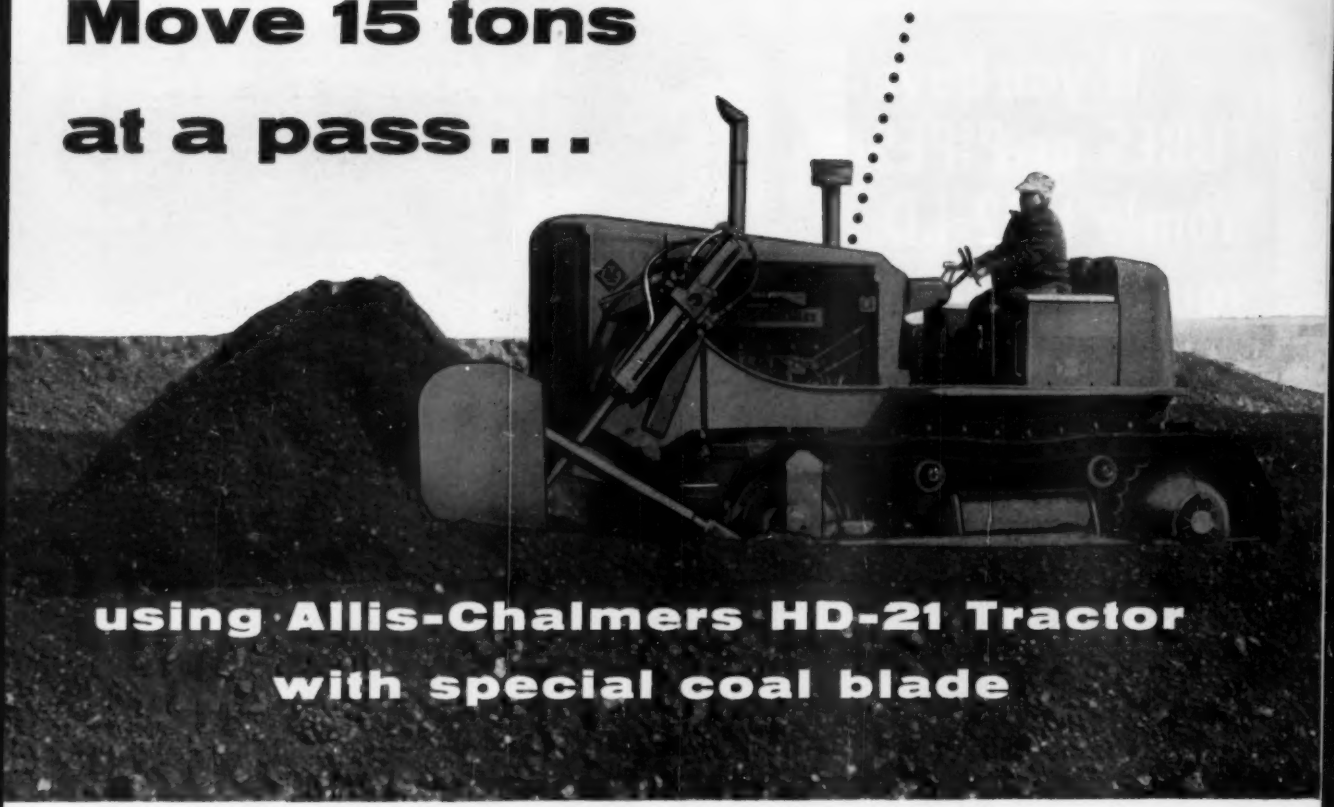
26—SOLENOID VALVE is diaphragm action type

Because of its diaphragm action and full flow ports, the K-181 Valve is reported capable of handling large capacities with minimum pressure drop, making it suitable for shutoff control of a variety of liquids and gases over a wide range of operating pressures to 250 psi. Great flexibility is attributed to company's multipoised design, which provides for operation in any position, including side and inverted mountings. The K-181 comes in ⅜- and ½-in. ips, in two basic models. Standard models handle a wide range of general applications using air, water, gases or light oils. Hot water models are declared particularly suited for controlling water at temperatures to 200 F. K-181 Valves are normally closed, have brass bodies, packless construction, two-wire continuous duty solenoids. Valves are also available with optional waterproof coil, an explosion-proof housing and manual opening device. General Controls Co.

27—GAS-OIL BURNERS for industrial applications

Each model of this line of burners has an integral air register. No checker floor is needed says company. Burner section and air register are shipped as separate

Move 15 tons at a pass . . .



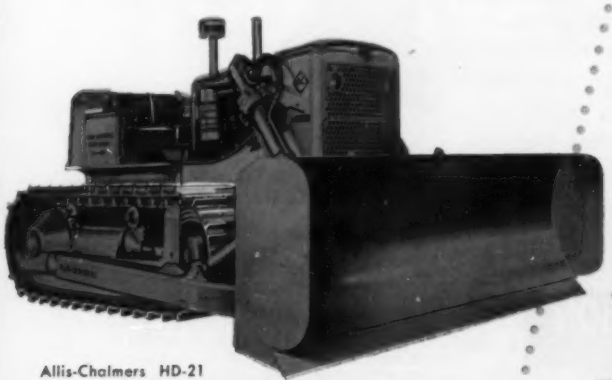
using Allis-Chalmers HD-21 Tractor with special coal blade

A special coal-handling blade now available for the Allis-Chalmers HD-21 fully uses the tremendous power and weight of this big tractor to move 15 tons of coal at a time.

HD-21 is coal-handling specialist— With its 204-hp diesel engine, the HD-21 has plenty of power for moving big loads. The hydraulic torque converter drive multiplies drawbar pull up to four and a half times, automatically accelerates to the highest traveling speed conditions permit. The torque converter permits climbing steeper grades, prevents killing the engine or digging in at soft spots, eliminates effort and time lost in shifting.

The compacting effect of a crawler tractor is well known. Through repeated trips over the coal pile, the 26-ton HD-21 and blade eliminate voids, prevent spontaneous combustion. The blade is shaped to move coal easily with a minimum of coal separation.

Dependability of the HD-21 is assured by Allis-Chalmers advanced design — Box-A Type Main Frame, one-piece steering clutch and final drive housing, straddle-mounted final drive gears, roller bearing truck wheels, through-hardened track rails — which also mean long life, less maintenance and faster repair when necessary.



Allis-Chalmers HD-21 tractor has 204 net engine hp, weighs 26 tons complete with cable or hydraulically controlled blade. Special coal blade has extra 56½-in. height and 15-ft length, plus boxed-in ends to carry 15 tons or more at a pass.

For additional information about the HD-21 tractor and coal blade — or about the other Allis-Chalmers tractors, tractor shovels, scrapers and motor scrapers — see your Allis-Chalmers construction machinery dealer or write direct to the company.

ALLIS-CHALMERS, CONSTRUCTION MACHINERY DIVISION
MILWAUKEE 1, WISCONSIN

ALLIS-CHALMERS

If you have TUBES or PIPES from ½" to 12" I.D. you can't clean thoroughly

Try ROTOJET®

Rotojet Tube Cleaners, driven by air, steam or water, are made for straight or curved tubes and pipes from ½" to 12" I.D. Send us your problem.

ELLIOTT COMPANY - ROTO DIVISION
Tube Cleaner Specialists Since 1910
147 Sussex Avenue, Newark, N. J.

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units, but are easily bolted together on the job, manufacturer points out, and this ease of installation is advantageous on industrial conversion jobs. The burner is company's latest model rotary cup type, designed to fire with No. 6 or lighter oil. Oil burner ratings run from 9 to 125 gph. The ring-type gas burner has multiple tubular stainless steel jets threaded into the cast iron manifold ring. It may be used with natural or manufactured gas and capacities range from 1,650,000 Btu input per hour to 18,750,000 Btu input.

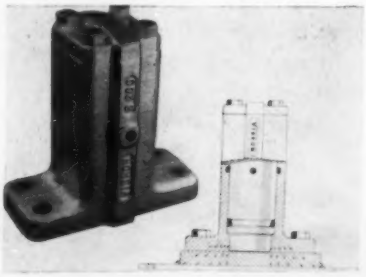
Fuel changeover is accomplished by operating a selector switch, or of reliance on automatic controls. No mechanical changes are necessary, it is noted. Electronic combustion controls are provided to automatically shut down the burner in case of abnormal conditions, and a programming control to schedule burner sequence. An automatic starter switch is provided for oil burner motor. Iron Fireman Mfg. Co.

28—PROCESS PUMPS for light non-viscous liquids

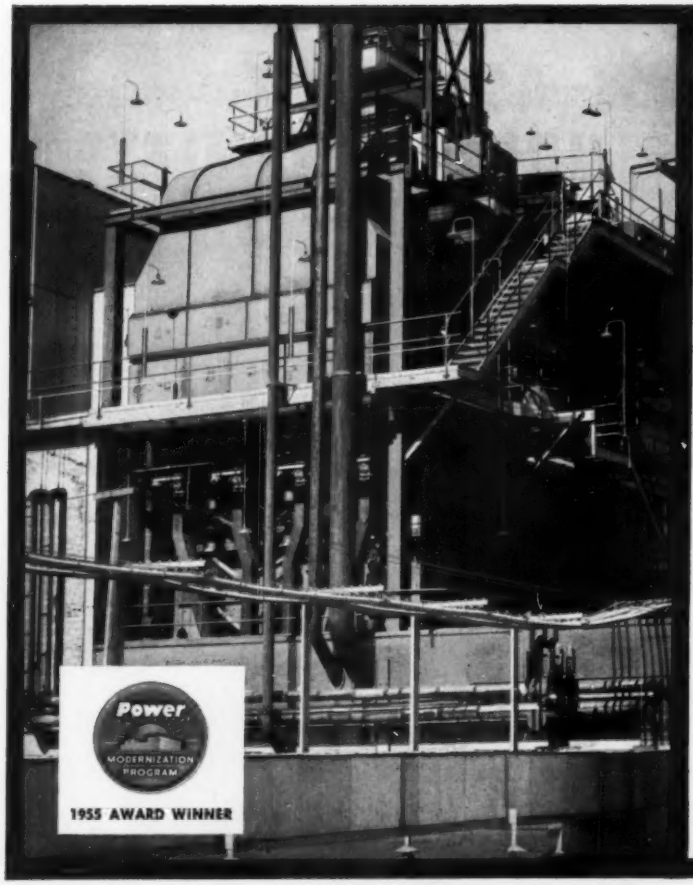
Turbine-type single and double stage process pumps in the series APCO-Z4 are intended for handling liquefied petroleum gases, refrigerants and other light non-viscous liquids. The pumps are available in any machinable alloy such as nickel, Monel, stainless steel. They operate at low suction head requirements to assure a positive, non-pulsating flow. There is claimed to be no shaft leakage because minimum pressure is exerted against the mechanical seal through the use of built-in pressure relief. Balance holes on both sides of the impellers equalize pressures in single-stage pumps to provide balanced hydraulic loads. Impeller loads of two-stage pumps are balanced radially by opposing pressures between stages. Aurora Pump Div., The New York Air Brake Co.

29—SHOCK COLUMN VIBRATOR speeds material flow

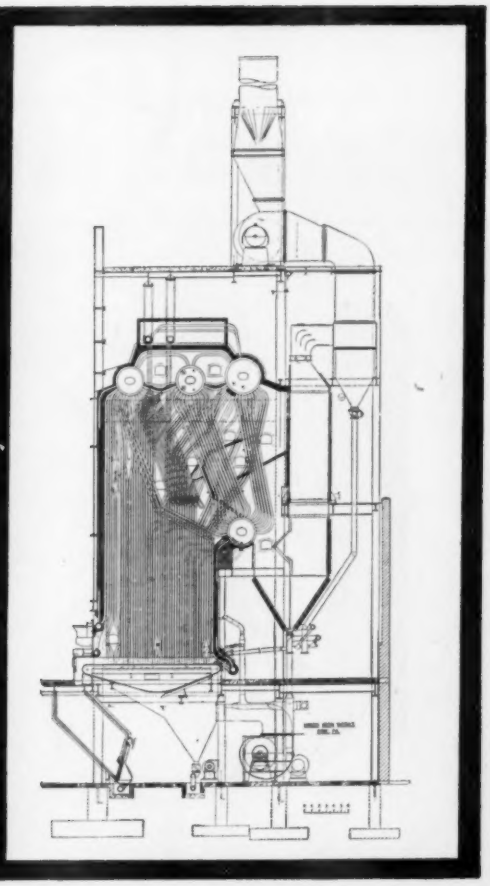
Monocoque in body design, the Vibron Shock Column Vibrator is designed to speed flow of wet or stuck materials in rigid bins, chutes and hoppers, and to



eliminate hazard of bolt breakage. According to company engineers, the heart of the unit is a combination of high strength one piece body incorporating a high compression drive and a shock column impact system — from a work production standpoint, the power of each stroke is greatly increased by using a high compression cycle in place of conventional air cushioning to drive piston against anvil. In turn maximum impact against anvil is said to be assured at all times. Burgess Sterbentz Corp.



John Strange Paper Co., Menasha, Wisconsin



Longitudinal Section of Union Boiler

165,000 lbs/hr Union Boiler plays key role as John Strange wins power modernization award

Named 1955 winner of POWER Magazine's Modernization Award, John Strange Paper Company is ranked with the leaders in its industry on the basis of BTU's used per ton of paper produced.

In remodeling its power plant, John Strange followed the recommendations of Cummins and Barnard, Inc. A Union 4-drum boiler was installed to supply steam for both electrical power and processing.

With a steaming capacity of 165,000 lbs/hr at 725 psig and 825° F, this Union semi-outdoor boiler has played a key role in helping boost paper production 10% while saving 29% in fuel costs without increasing plant personnel.

From start to finish, the report "How John Strange Paper Company Modernized Its Steam Generation Plant" is an interesting example of planning power services around a process. It typifies the way in which Union Boilers perform in numerous industrial installations from coast to coast.

GET FULL DETAILS
Both a copy of this story, as it originally appeared in POWER, plus illustrated Catalog GB-153 showing several types of boilers built by Union, will be mailed on request. Write.

UNION

UNION IRON WORKS
ERIE, PENNSYLVANIA

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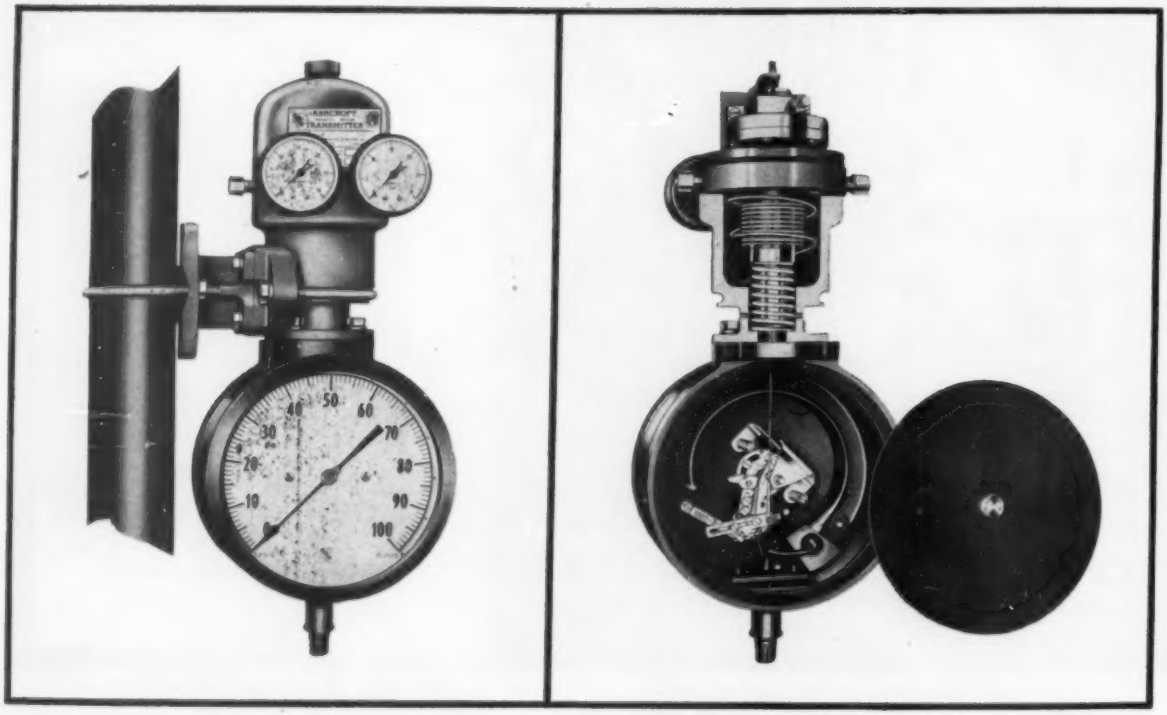
Designed to solve safety and service problems

...THE NEW ASHCROFT PNEUMATIC PRESSURE TRANSMITTER



This new Ashcroft Pneumatic Pressure Transmitter is particularly recommended to processing industries and power stations. It combines speed and accuracy with maximum protection and serviceability.

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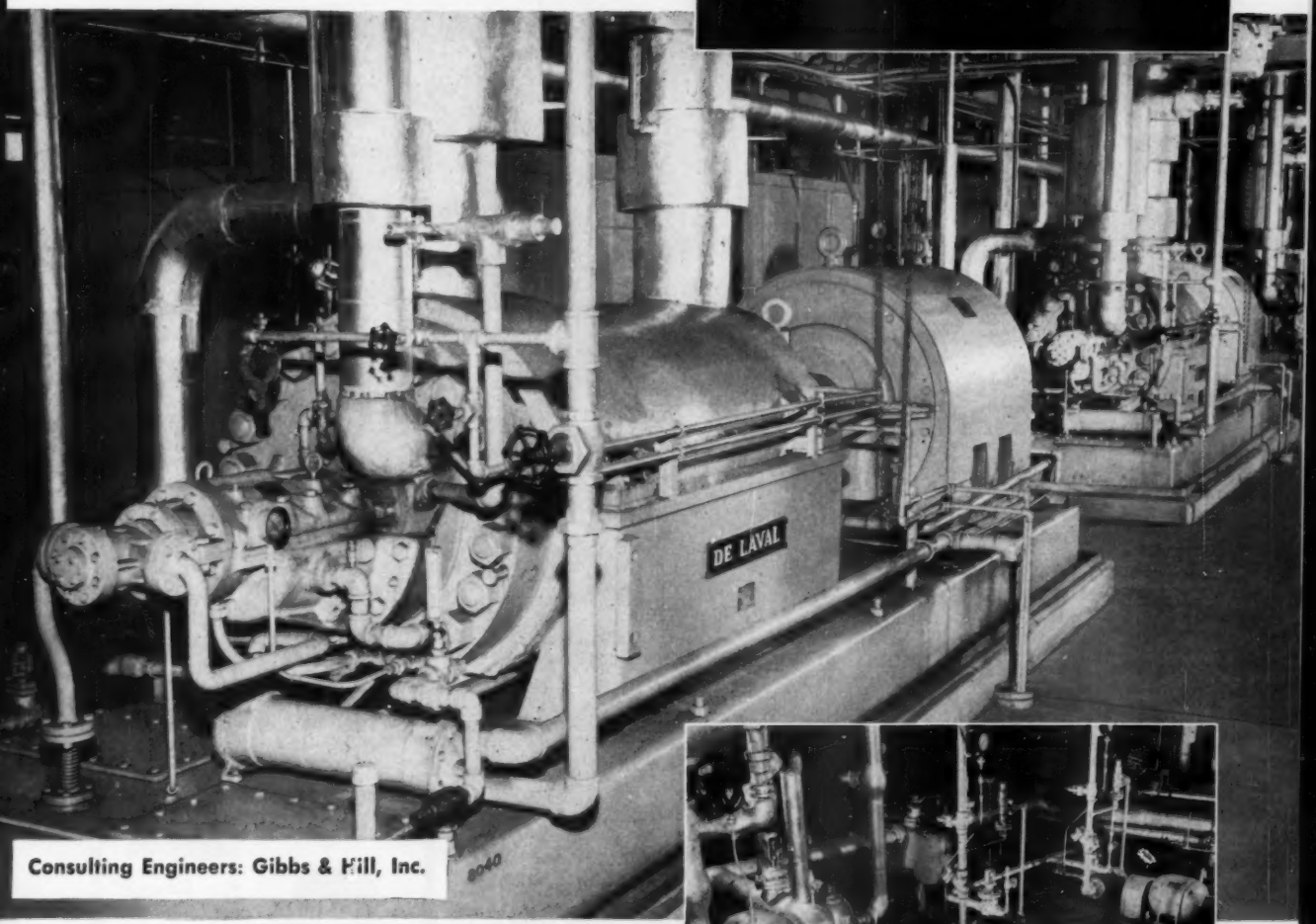

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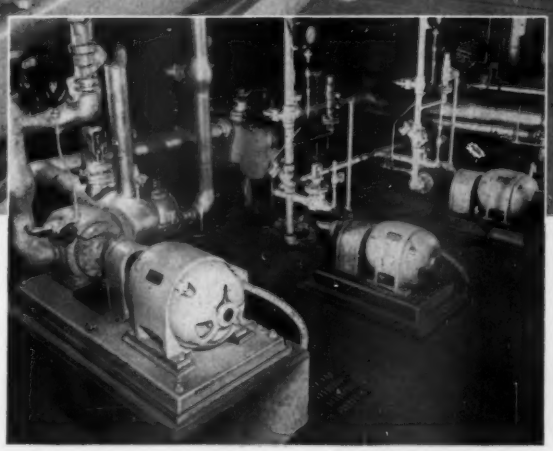

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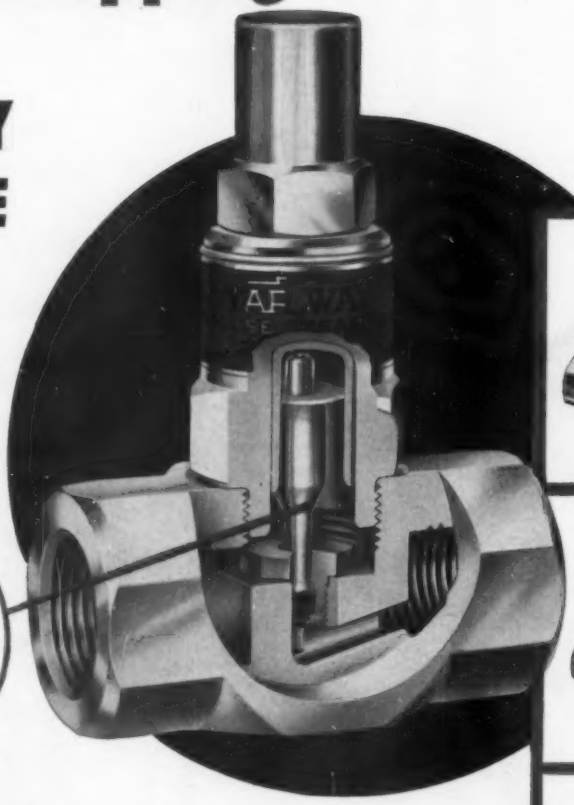

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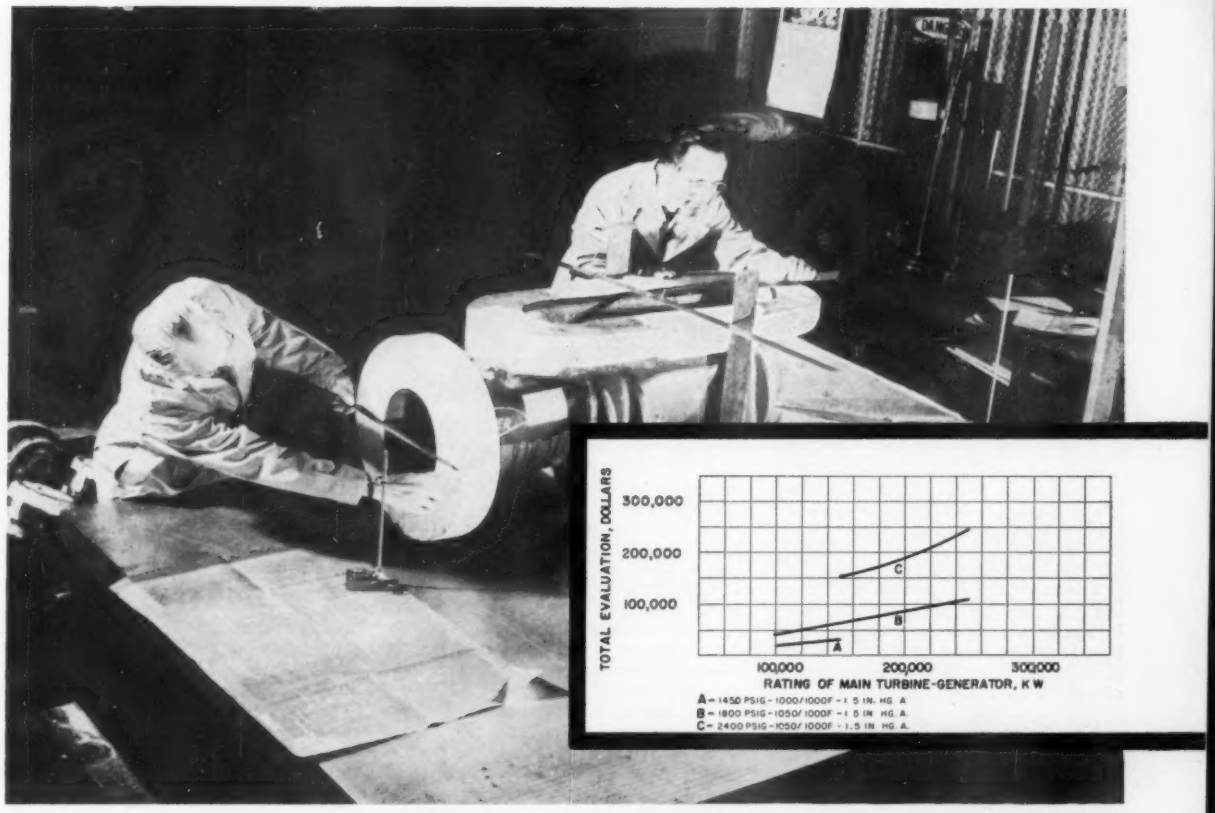
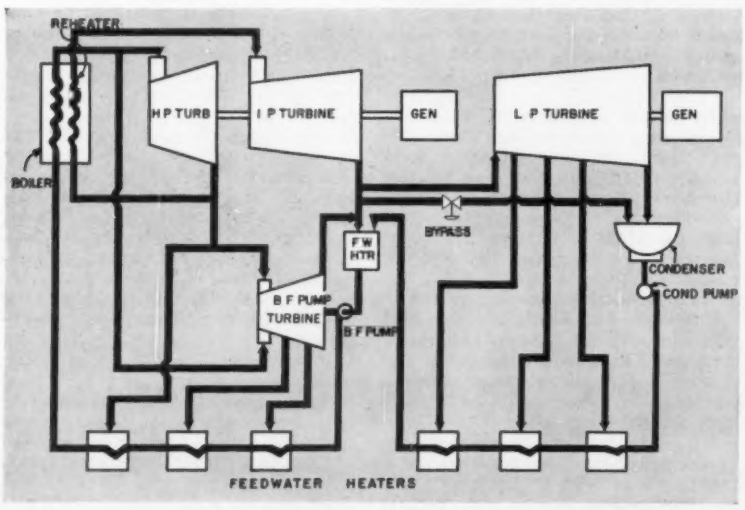


Fig. 1. Approximate total evaluation favoring turbine driven against motor driven boiler feed pumps. Includes investments for same new kw output and evaluation of heat rate. Background photo, steam chest casting for b-f pump turbine

Turbines Stage Come-Back for Large B-F Pump Drives



In the early days, steam turbine drives were preferred for b-f pumps, then for many years the electric motor took over. Now turbine drives are coming back to meet new station demands

By J. F. RANSOM * AND E. L. PACE †

THE APPLICATION of turbines for boiler feed drives is not new. In fact, when centrifugal pumps began to replace reciprocating pumps, turbine drives were favored over motors because continuity of boiler feed service in case of power outage was considered a necessity for the boilers then in use.

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Fig. 2. Schematic diagram showing typical cycle arrangement which includes a non-condensing boiler feed pump turbine

The larger sized boilers of this earlier era had stoker fired coal furnaces with large amounts of heat stored in the bed of coal and refractories which kept the boiler steaming for a considerable time after the feed of new fuel had stopped. Thus, the continuity of feedwater supply was a necessity.

From 1925 to 1940, great progress was made in steam power generation. Boilers of larger unit capacity and higher steam pressures and temperatures were developed. Stokers with heavy fuel beds gave way to pulverized coal, oil, and gas firing, which coupled with increasing amounts of water wall surface, served to reduce heat storage making continuity of boiler feed service less critical.

Higher pressures and temperatures tended to increase the cost of turbine drives as compared to motor drives, and electrical auxiliary power systems became much more reliable. The comparatively small size of the feed pump drivers was not conducive to high turbine efficiency so that it became more economical to generate power for auxiliaries in the large turbine generator, despite the losses in the motor drive and electric auxiliary system. These were the factors that led to the eventual replacement of turbines with motor drives.

New Interest: Today, on the other hand, a new interest in turbines for boiler feed drives is developing, born of progress in steam power generation. Continuing trends to greater capacity and steam pressures have increased the power required in boiler feed drives. The increase in size tends to favor turbines because the cost per horsepower of turbines decreases rapidly and efficiency improves as size increases.

Two other important factors favor the use of turbine drives. These are (1) an increase in net station output at an attractive cost, and (2) an improvement in net station heat rate.

Progress has also been made in the design of feed pumps. User confidence in pump reliability has resulted in pumps of larger size and advantage is taken of the investment cost savings afforded by a few large pumps over a greater number of smaller pumps. One utility is planning to use only one full capacity turbine driven feed pump on their newest installations. Higher speed pumps have been developed so that fewer stages and shorter rotors are required for high pressure applications.

Turbine drives are not only well suited to these higher speeds, they are inherently a variable speed drive and the value of variable speed drives increases at higher pressures. Gains from variable speed drives are of two forms, (1) power saving and (2) lower pressures imposed on heaters and piping.

Developments in feed pump mechanical design have bolstered confidence so that larger unit sizes of feed pumps are being employed and less spare capacity is felt necessary. With the vast interconnecting systems of large utilities, no spare capacity is provided in several instances.

Thus some recent economic studies, of very large central station installations have resulted in a decision to use steam turbine driven feed pumps. These were stations with unit capacities in the order of 200,000 kw or larger and initial pressures of 2000 psig or higher with reheat. The three principal factors in such an economic study are:

1. Relative investment costs
2. Relative net station capacity
3. Relative net station heat rate

These items when considered together show favorable economics for turbine drives in station unit sizes as low as 150,000 kw. The merit of turbine drives increases as the unit size increases. Let us first discuss the type of plant considered and how the turbine driven feed pump is fitted into the cycle.

Only plants employing high pressure reheat cycles were considered. Fig. 2 shows a representative cycle arrangement employing a non-condensing turbine operating from the cold reheat line of the main turbine with exhaust to a feedwater heater and extraction to two other feedwater heaters.

Extraction from the main turbine to the heater at the exhaust of the pump drive turbine supplements the steam for feed heating at high loads and the cycle may, in some cases, be arranged for admission of excess steam to the main unit at light loads. Use of relatively low initial pressure steam taken from the cold reheat line provides high volumes flow to the feed pump turbine and permits a relatively high internal efficiency.

For light loads and also for starting, steam from the main steam line is necessary. For this purpose a separate admission stop valve and control valve is employed. Also for starting up and very light load operation, a bypass from the turbine exhaust to the condenser is necessary, and for starting, a small, low head, motor driven pump is required.

Economic Comparison: With this background of a typical cycle arrangement, we may consider how turbine drives and motor drives for the feed pumps can be compared economically.

One method for making this comparison would consider the relative cost of obtaining a specified number of kilowatts available to the transmission line with turbine driven and with motor driven pumps. To do this, we must evaluate the effect on various components of the station of changing from motor driven to turbine driven pumps.

The principal effects noticed are: (1) electrical auxiliary power requirements are reduced by the amount of the feed pump power, and (2) due to changes in flow to various sections of the main turbine, heat output of the boiler and heat input to the condenser are increased. Additional kw equal to reduction in electrical auxiliary power requirements are available to the transmission line. To obtain the same increase in kw available for transmission using motor drives, the rating of all components in the plant must be increased.

To find the difference in investment for these two conditions, the following items should be considered:

1. Initial cost of motor, adjustable speed transmission or pump discharge throttling control and pump vs. turbine and high speed pump plus the small motor driven starting pump.

2. Additional piping costs for turbine driven pumps taking into consideration changes in extraction steam lines to the feed water heaters, interconnections with the main unit, and modification of the main unit, if necessary.

3. Difference in cost of auxiliary power system, taking into consideration the following possible savings with turbine drive:

a. Breakers of lower interrupting capacity.

b. Savings resulting from lower voltage levels due to lower auxiliary power system requirements.

c. Auxiliary power transformer capacity.

d. Station start up transformer capacity.

4. Change in capacity of main power transformer in the amount of the power otherwise required for feed water pumping.

5. Additional boiler capacity required, including auxiliaries.

6. Additional condenser capacity required, including auxiliaries.

The usual arrangement in power plants is three half-capacity boiler feed pumps, driven by electric motors. The most economical arrangement with turbine drives that offers comparable standby protection, is two full-capacity pumps. The comparisons made here are on this basis.

The table shows the result of comparing turbine driven and motor driven pumps in a station with a 200,000 kw main turbine for steam conditions 2400 psig, 1050/1000 F and 1.5 in. Hg.

Investment data for the table was obtained from Economic Comparison of Steam Turbine vs. Motor Driven Boiler Feed Pumps.[1] Briefly, the information was derived as follows. From reports of costs on a large number of coal fired plants, a representative curve of cost vs. plant size was established and from this a curve of cost per incremental kw was obtained.

Incremental costs for the boiler plant were obtained in a similar fashion. Like data was established for condensers and power transformers. Actual costs were secured on pumps, drivers, piping and auxiliary power systems. Table I was derived from a combination of these figures.

The plant efficiency using turbine

drive will usually be improved by 10–15 Btu per kwh, compared to motor drive, at full load. For evaluation over the load range on a typical operating schedule, the advantage will probably be greater than 15 Btu. Using 15 Btu as a conservative figure, and assuming that 1 Btu kwh can be evaluated at $2500 for capitalized saving in fuel costs, an additional economic advantage of turbine drives is obtained.

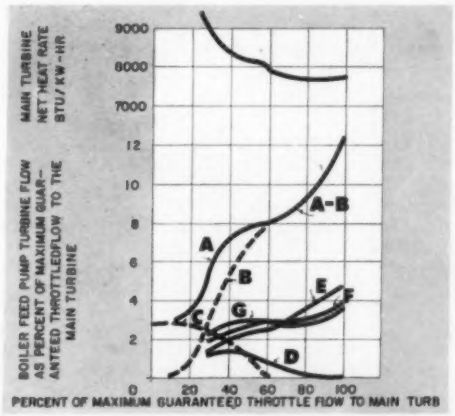
Figure 1 shows the total evaluation in favor of turbine drives over a wide range of kw rating and steam conditions. Since reference [1] did not evaluate the heat rate and since the calculations therein were made by a slightly different method, the results are not exactly the same as in Fig. 1 but they agree fairly closely. The conclusions to be drawn are not affected by this small difference.

Each individual may have his own procedures of making an economic comparison of turbine driven and motor driven feed pumps. The method we have used is only one example. It is a logical method that we feel will give results that are representative and reasonably reliable for most circumstances. While figures may vary, we believe that the conclusions will not be significantly affected.

Cycle Arrangements: The number of variations of cycle arrangements using turbine driven boiler feed pumps is almost infinite; however, much of the difference is in details that are relatively minor. As important items of variation, feed pump turbines can be classified first as to condensing or non-condensing, and second as to location in the cycle.

Both condensing and non-condensing pump turbines improve the station heat rate, over a wide range of steam pressures and kw rating for the main turbine. Condensing turbines usually provide the greater heat rate improvement, particularly if the exhaust loss of the main turbine is high. Pipes required for condensing turbines are fewer, but much larger, and if water must be supplied to the boiler when vacuum is lost on the main condenser, a separate condenser may be needed.

Both classes of turbine provide a variable speed pump drive, which results in power saving and reduction in design pressure for heaters and piping, compared to constant speed drives. Turbines usually can be directly connected to the high speed (5000–9000 rpm) pumps that have been developed in recent years for high pressure boilers. Noncondensing turbines require less space than motors or condensing turbines. They offer an opportunity to simplify piping under the reheat turbine, by taking corresponding extractions from the feed pump turbine.



Curve A: Total throttle flow
" B: Throttle flow from cold reheat line
" C: Throttle flow from boiler
" D: Flow from exhaust to main turbine crossover
" E: First extraction flow
" F: Second extraction flow
" G: Total exhaust flow

Fig. 3 Curves showing relationship between steam flow to boiler feed pump turbine and guaranteed throttle flow to main turbine

Non-condensing turbine drives will result in lower overall installed cost than condensing turbines. The cycle can usually be arranged with non-condensing turbines to provide favorable conditions with regard to installation and operation of the deaerator, as discussed in detail below.

The comparison above is very general. Other advantages of a particular arrangement that will influence the choice of a cycle, may be found in individual applications.

Design of Cycle With Boiler Feed Pump Turbines: While the most economical arrangement may not have the best heat rate, the differences in heat rate will be minor. It is well to observe as far as practicable the following basic principles involved in designing an efficient cycle:

1. When condensing boiler feed pump turbines are used, throttle steam should be extracted from the reheat turbine. A gain in cycle efficiency is made by reducing the exhaust flow, and therefore exhaust loss, of the main turbine for a given generator kw. The greatest gains, therefore, are made when exhaust loss of the main turbine is high.

There should be no extraction from the feed pump turbine. This would sacrifice part of the potential gain; flow through the last stage of the main turbine and therefore its exhaust loss, would not be minimized.

2. When non-condensing boiler feed pump turbines are used, their throttle steam should be taken from the cold reheat line. Where this can be done consistent with good heater distribution, all extraction and exhaust steam should be used for feed water heating, in successive heaters below the heater at the reheat point.

A thermodynamic gain is realized by heating the feedwater with steam of lower temperature than could be extracted from the main turbine. Use of cold reheat steam results in a substantial reduction in the cost of the boiler feed drive turbine.

Other locations in the cycle than those recommended above for either condensing or non-condensing turbines may be desirable because of conditions peculiar to the particular application. In general, we believe that these suggestions will result in the most economical installation and in best operating characteristics.

Cycle efficiency gains of .1 to .5 per cent often result from use of stream turbine driven boiler feed pumps instead of conventional arrangements. In a few cases the gains may be even higher.

A typical cycle arrangement with a non-condensing extraction boiler feed pump turbine is illustrated by Fig. 2, and is described briefly earlier in the article. An installation has been designed according to this cycle and is expected to be in operation early in 1957.[2] The feed pump turbine takes throttle steam from the cold reheat line, extracts to two feed water heaters, and exhausts to a third heater, which is also connected to the main turbine.

This connection can provide any additional steam required by the heater at high loads on the main unit and readmits the excess of exhaust steam flow over heater requirements to the main turbine at light loads. For starting and light load operation, the feed pump turbine is equipped with separate nozzles and control valve that admit steam directly from the boiler, when no steam is available from the cold reheat line, or when, for any reason, the pump load is greater than the power available from cold reheat steam admitted by the low pressure nozzles.

At loads below 20 per cent on the main unit, the valves in the re-admission line are closed, and excess exhaust steam goes to the condenser. This same valve position applies to starting, which can be accomplished at a low boiler pressure (150–300 psig) on conventional drum-type boilers. This pressure can be provided by a small motor-driven pump. After the station has been started and is on the

(1) Reference numbers in article refer to bibliography at end of article.

line, operation is automatic over the complete range of load.

Curves of boiler feed pump turbine flow for a typical installation using this cycle are shown in Fig. 3. From maximum load down to about 60 per cent in this example, the turbine operates on cold reheat steam alone (curve B). At lighter loads throttle steam is also required from the boiler (curve C) and the turbine runs on both cold reheat steam and boiler steam down to about 10 per cent load.

At lighter loads, cold reheat pressure is below the first stage shell pressure of the feed pump turbine, and it must operate only on boiler steam. At maximum load, exhaust heater demands very nearly equal feed pump turbine exhaust steam flow. Pump power at light load requires more steam than can be absorbed in the feed water heaters and the excess exhaust flow is returned to the main turbine (curve D). Below 20 per cent load, the valves in the return line to the main turbine are closed, the valve in the line to the condenser is opened, and the excess steam goes to the condenser.

The arrangement just described permits operation over a wide range of load without requiring admission of high pressure steam from the boiler. The feature of re-admission of exhaust steam to the main turbine may be limited to cases for which the main turbine crossover pressure is favorable to this arrangement.

Since exhaust temperature of the feed pump turbine may be appreciably lower than temperature in the main turbine at the same pressure, it is not desirable to readmit this steam through an extraction opening. Admission at an extraction opening may provide inadequate mixing to avoid stratification of temperatures in lower stages of the main turbine.

When the exhaust of the feed pump turbine is connected to the main turbine at some point other than the crossover, the cycle can be arranged so that no re-admission to the main turbine is necessary. In this case, the heater pressures are chosen so that at maximum load, an appreciable part, perhaps 20 to 30 per cent, of the exhaust heater steam requirements is taken from the main turbine. This allows reducing the load on the main turbine to 50 or 60 per cent of maximum throttle flow before the exhaust heater ceases to require steam from the main turbine.

Then a non-return valve in the connection to the main turbine will close, and, at lighter loads, there will be no flow in this pipe. The exhaust heater pressure will rise until it absorbs the exhaust steam flow of the turbine resulting from the pump power demands. High pressure steam will be required at about the same time that this non-return valve closes.

If the deaerator is connected to the exhaust or an extraction opening of the boiler feed pump turbine, the arrangement described just above will usually keep its pressure appreciably above atmosphere over the entire load range automatically. Since, upon sudden loss of load on the main turbine, some boiler steam will still be required to drive the feed pump turbine, there will be steam supplied to the deaerator to prevent sudden decrease in pressure. With proper consideration in design, it may be possible to obtain adequate not positive suction head for the feed pump with appreciably lower elevation of the deaerator than would otherwise be required.

The descriptions above represent two cycle arrangements with non-condensing feed pump turbine. Other cycles may be advantageous under special conditions.[3]

There is nothing radically new in any of the ideas here represented, as in one form or another each of the features has been employed in similar applications in the past. Dual pressure admission to the first stage, with one admission at variable pressure from an extraction on the main unit, was applied on a single-stage boiler feed drive in 1937, and there have been many multi-stage turbines exhausting and extracting to station feedwater heaters. This experience has been valuable from the standpoint of cycle arrangement and also in the design of the turbines themselves and their control.

In the design of the turbine, particular attention must be given to:

1. Ease of operation
2. Reliability
3. Efficiency

Control of The Turbine: Under normal plant loads the speed of the turbine will be determined by conventional boiler feed water control equipment. A change of speed requirement as indicated by the feedwater control will be pneumatically or hydraulically transmitted to a device on the turbine which will act to change the position of the control valves as required.

This device may position the control valves either through the speed governor or independently of the speed governor in which case the speed governor becomes a speed limiting governor. Both methods are used.

Starting: Some form of motor driven pump will generally be required for starting a cold plant. In the case of conventional drum type boilers, the motor driven pump need only be sufficient to establish a relatively low head of from 150 to 300 psi. This motor driven pump may be a low head, low capacity pump in parallel with the main feed pump, or it may be a booster pump capable of handling the same flow as the main feed pump except at lower head with discharge to the suction of the main feed pump.

In the case of a 200,000 kw plant at 2400 psig, about 500 hp of motor driven booster pump capacity is sufficient to establish the starting pressure and flow required. If the pump is to be used only for starting, a much smaller pump may be used.

Once steam pressure has been established, the boiler feed drive turbine may be started in the conventional sequence of operations.

If desired, the turbine may be arranged for remote starting.

With the stop valves closed, trip mechanism latched in, and control valves closed, the stop valves may be opened simply by starting the motor driven auxiliary oil pump. The stop valves will open as soon as hydraulic oil pressure is established and the

Comparison table between turbine and motor drive for pumps for 200,000 kw unit

Additional cost of pumps and turbine drives over pumps transmission and motor drives	$ 90,000	
Additional piping and valves, considering changes to extraction lines to feed water heaters, interconnections with the main turbine	100,000	
Provision for extracting steam from main turbine for feed pump drive	40,000	
Additional capacity of boiler and auxiliaries (heat output increased 2.5%)	240,000	
Additional capacity of condenser and auxiliaries (heat input increased 2.5%)	50,000	
Additional capacity of main transformer	9,000	
Savings on auxiliary power supply	− 88,000	
Savings on other motors due to lower voltage	− 30,000	
Net increase in investment	$411,000	
Increase in net kw output (kw released by turbine driven pumps)	5200	kw
Cost of an incremental kw of net output with turbine drive 449000/5200 =	$ 86	
Increase in generator rated kw with motor driven pumps to obtain 5200 kw increase in net output $\frac{5200}{0.974}$ =	5340	kw *
Cost of station per incremental kw of generator output with motor drive	$ 105	
Cost of complete station for 5340 kw additional generator rating	561,000	
Difference in total investment favoring turbine drive (561,000-449,000)	150,000	
Evaluation of approximately 1.5Btu/kwh difference in heat rate favorable to turbine drive, at $2500/Btu	38,000	
Difference in total evaluation favoring turbine drive	$188,000	

* 0.974 is a factor to account for 2.6 per cent feed pump power requirements with motor drive.

steam pressure across the stop valve disk has been balanced. A small poppet in the main valve disk opens first to permit the pressure to balance.

With the stop valves opened the control valves may be opened. This may be accomplished through a manual control of the pneumatic or hydraulic transmitting medium to the turbine governing system; or if desired, this may be accomplished through a separate electric motor driven speed adjusting device.

Since normally the valve admitting high pressure steam will be the last to open, all the low pressure valves will be open during starting but without flow, since there will be no source of cold reheat steam. A check or non-return valve will be necessary to prevent a back flow of steam to the cold reheat line.

During the starting operation, exhaust will be to the condenser with possibly just enough throttling to provide a source of steam for feedwater heating. To eliminate air leakage under conditions of exhaust to vacuum, provision must be made for steam shaft sealing, as well as gland leak evacuation. This may be, if desired, a part of the main turbine generator's sealing system or it may be separate equipment.

The main unit may be started if desired at a pressure appreciably below normal operating pressure. When boiler pressure is established, the main unit may be brought to speed and synchronized and feed water controls transferred from manual to automatic in a fashion similar to what it would be in the case of motor driven feed pumps.

When feed pump turbines are noncondensing the exhaust to the condenser may be closed at some light load on the main unit. If the cycle is designed with admission of exhaust steam to the main unit, valves in this line may be opened at about 20 per cent load on the main turbine.

As load is applied to the main unit, pressure is built up in the cold reheat line and as steam flows to the pump drive turbine, the high pressure admission control valve closes. The load at which all steam will be taken from the cold reheat line will vary with each application. In general, it is expected this will be about 50 to 60 per cent load on the main unit.

Emergency Conditions: To provide maximum reliability, the turbine driven feed pump and the system in which it operates are so designed that operator attention is not required under abnormal conditions such as a load trip-out, or loss of vacuum.

In the case of a trip-out, the turbine controls must immediately open the high pressure admission. Under these conditions, the boiler feed turbine will require more steam than can be absorbed in heating feedwater and, of course, no steam could be admitted to the main unit.

The admission valves to the main unit, if any, must be tripped closed. The excess steam in this case may be by-passed to the condenser. In the event of loss of vacuum, the dump valve to the condenser must not be opened. Instead, the excess must be blown to atmosphere through a relief valve.

In the case where two full capacity boiler feed pumps and turbine drives are used, only one pump will normally be in service. If, for some reason, the second pump must be put in service, this may be done quickly. To assure a straight shaft, the pump drive turbine should be equipped with a turning gear. Careful design, together with the inherently small turbine for high speed service, makes quick starting feasible. It is expected the turbine will come to speed safely as fast as the stop valves and control valves can normally be opened.

If the turbine is to be ready for quick starting, provision must be made to keep throttle, extraction and exhaust lines well drained. Seal steam may be applied and the exhaust valve may be kept open without ill effect as long as the turning gear is in operation.

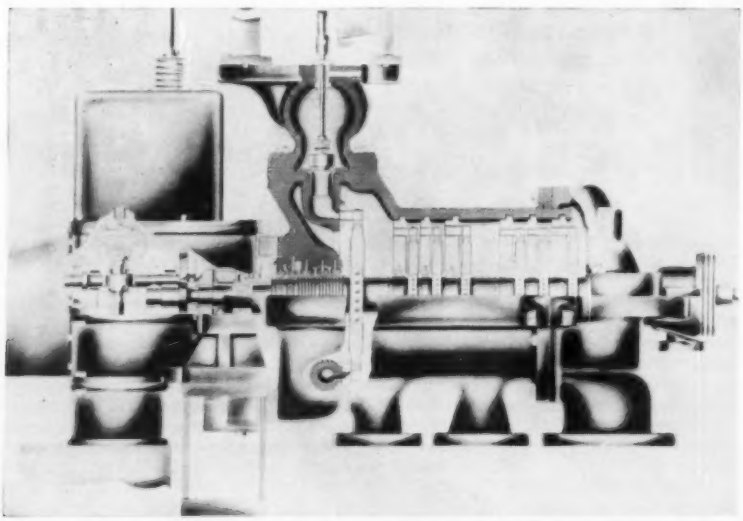


Fig. 4. Section through typical turbine for central station boiler feed pump drive

Turbine Design: To assure reliability equal to that of the main turbine generator, the turbine must be designed so that parts exposed to rapid variations of steam temperature have provision for dimensional adjustment to minimize distortions and unusual stress. This is particularly true of inlet parts.

Other parts such as horizontal flanges and rotor masses should be capable of rapid and uniform heating. A number of large steam pipes may be connected to the turbine, and the casing and its supports must be designed to withstand the large forces that may be imposed. Desirable features are guarded oil piping to confine possible leaks and continuous lubrication of the coupling.

A cross-section of a machine so designed is shown in Fig. 4.

Many additional features may be applied to make the turbine driven pump suitable for remote operation and testing, such as:

Remote trip
Remote reset of trip device
Device for remote engagement of turning gear
Remote testing of stop valves
Valve position indicators
Tachometers
Remote reading pressure gages
Interlocks to insure safe operation.

Plant heat rate is affected by the efficiency of the boiler feed pump turbine, to the extent of about .05 per cent for 1 per cent efficiency change on the feed pump turbine for a typical 2400 psig station. Efficiency of the feed pump turbine is affected by choice of internal design such as wheel diameters and emergency per stage, and also by choice of location in the cycle and distribution of heater enthalpy rises.

These last two items also affect the cycle efficiency directly as well as through their influence on efficiency of the feed pump turbine, and they should be chosen so that the combination of investment and evaluation of cycle efficiency is optimized. Experience indicates that this choice may be made readily.

Supercritical Installations: Previous discussion has been devoted to cycles suitable for conventional drum-type boilers. When steam pressures are above the critical pressure of water, boilers of the once-through type are used, which have no steam drum. In these boilers, it is necessary to have a fairly high pressure drop to obtain good distribution of flow.

To assure proper flow distribution, the practice *continued on page 120*

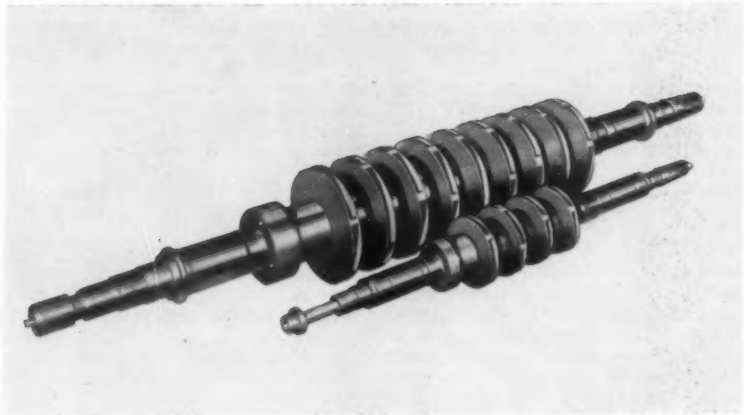


Fig. 1. This large 9-stage rotor operates at 3465 rpm. The small one runs at 9000 rpm in a 4-stage pump, designed for 1380 gpm against a total head of 6550 ft

In this article the author explains why high-speed b-f pumps are necessary to meet demands of modern steam generating stations. He reviews historical developments and outlines present practice

High-Speed Boiler Feed Pump

By IGOR J. KARASSIK *

ANOTHER article in this issue presents a very complete economic comparison of steam turbine driven vs motor driven boiler feed pumps for large high pressure steam central stations and outlines a number of reasons which make the steam turbine a very attractive drive for today's applications.

The present article will concern itself with the reasons that led to the development of these higher speed pumps and with a historical survey of what has been accomplished to date.

It is important to realize that the main purpose in running boiler feed pumps at speeds from 6000 to 9000 rpm is to develop higher heads per stage, reduce the number of stages required to produce a given pressure and to reduce the overall size of the boiler feed pump. This reduction in size and in the number of stages is not a matter of economic consideration but rather of relative reliability.

In this connection, we must point out that the cost of the boiler feed pumps intended to serve today's high pressure steam power stations represents from 0.7 to 0.9 per cent of the total power plant cost and it is certainly not by skimping on the boiler feed pumps that the cost per kilowatt can be brought down. More than this, it should be noted that the boiler feed pump is one piece of power plant equipment in the selection of which it can be suicidal to compromise reliability for the sake of a slight price saving.

The reduction in the number of stages brought about by operation at high speed results in a marked reduction in shaft span and, of course, a decrease in shaft deflection. If the internal clearances are not reduced, the reduction in shaft deflection materially increases the reliability of the boiler feed pump.

It may be interesting to stop for a moment and examine the effect of high speed operation for a specific case. Figure 1 illustrates two rotors each designed to handle 1380 gpm against a total head of 6550 ft. The top rotor is that of a conventional 9-stage pump operating at 3465 rpm, while the rotor at the bottom is that of a 4-stage, 9000 rpm pump.

The relative deflection of any two shaft designs can be found by comparing the respective factors representing the ratio between the fourth power of the shaft span and the square of the shaft diameter at the impellers (L^4/d^2). In the case of the two rotors illustrated, the relevant data are as follows:

	Conventional Design	High Speed Pump
Shaft span (L) in inches	87 3/8	51 1/2
Average shaft diameter, in inches	4 3/4	3 1/16
Factor ($L^4/d^2 \div 1{,}000{,}000$)	2.575	0.75

In other words, the deflection of the high speed pump shaft will be less than one-third of that of the conventional pump.

The smaller size of the high speed pump carries with it another source of increased reliability, in that it reduces the area subject to internal pressures and therefore the stresses at the high pressure pump casing joints.

As a matter of fact, the pressures to be developed by boiler feed pumps intended to serve steam power plants operating at 3500 psi and above cannot be practically produced by 3600 rpm pumps and, of necessity, such pumps must be designed to run at 6000 to 9000 rpm.

At this writing, the high speed boiler feed pump has reached the stage where it is no longer considered an experimental unit. The first unit was built for the Public Service Electric & Gas Co. of New Jersey and installed in the Kearny Steam Station. This pump was designed to handle 592,500 lb per hr of 400 F feedwater against a discharge pressure of 2720 psig. It is a 4-stage pump, operating at 9000 rpm for its rated conditions.

In order to utilize the same type of drivers as for the remaining four conventional 3500 rpm pumps in this station, this high speed pump is driven by a 3000 hp, 3570 rpm electric motor through a hydraulic coupling and a step-up gear. This pump has been in regular service since late in 1954.

Since then, a total of 21 additional high speed boiler feed pumps have been ordered from the author's company for installation in land steam-electric central stations. These are listed in Table I.

In connection with the article on steam turbine drive appearing elsewhere in this issue of POWER ENGINEERING, it is especially interesting to note that of these 21 pumps, 7 will be driven by steam turbines. This pro-

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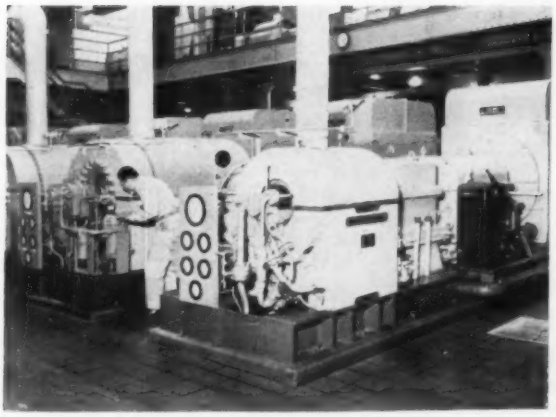

Fig. 2. First central station high-speed pump (foreground) at Kearny station of Public Service Electric & Gas Co. (N. J.)

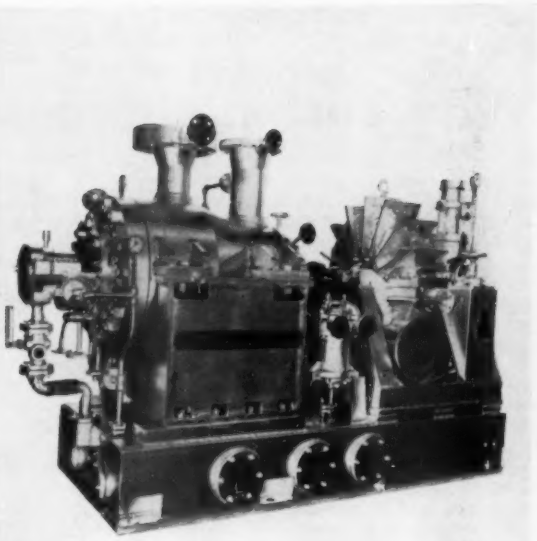

Fig. 3. Turbine driven b-f pump for aircraft carrier service

Meets New Needs

portion is in contrast with common practice over the last five years during which not a single turbine driven boiler feed pump was built by our company for central stations in the pressure range above 1250 psi.

It should also be noted that 26 high speed steam turbine driven high pressure boiler feed pumps have been ordered from our company by the U. S. Navy for service on the latest type of aircraft carriers. This pump is illustrated in Fig. 3.

The high speed pump requires more NPSH (net positive suction head) than the conventional 3600 rpm unit. In closed cycles, this presents no problem whatsoever, since the condensate pump can be readily designed to provide whatever margin over the vapor pressure at the main feed pump suction that may be necessary. In the case of open cycles, where the feed pump normally would take its suction from a direct contact heater, a booster pump can provide the required NPSH.

As a matter of fact, the use of the booster pump brings with it numerous advantages. In the first place, the booster pump is generally a slow, 1750 rpm unit which requires from 10 to at most 20 ft NPSH. This permits locating the heater appreciably lower than in the conventional plant.

The lowering of the heater has a favorable effect on the possibility of transient conditions during load drops. The reduction in the volume of the suction pipe between the heater and the booster pump reduces the residence time in the piping and conversely increases the allowable rate of heater pressure decay during these transients.

Furthermore, if the booster pump is selected to produce a head in excess of the minimum NPSH required by the main feed pump, the booster pump can be allowed to go into mild cavitation under certain emergency conditions without affecting the operation of the main feed pump.

Another favorable effect of the lowering of the heater is the ability of the closed heaters to cascade their drains to the deaerating heater by gravity at all loads, without pumping or moving the drains to the condenser.

If the main feed pump is motor driven, this motor will generally operate at 1750 rpm as the four-pole motor is considerably less expensive than the two-pole 3600 rpm motor and as a step-up gear will be used in either case. The simplest arrangement for the booster pump is to be driven directly from a second extension of the main motor.

When steam turbine driven boiler feed pumps are used, the booster pumps should be driven by a separate 1750 rpm electric motor. During the initial start-up, the motor driven booster pump would be used to fill and then to build up pressure in the boiler until there is sufficient steam pressure built up for the steam turbine driving the feed pump to start up and bring the pump up to speed.

While considerable attention to the possibility of raising the operating speed of the high pressure boiler feed pump had been devoted by pump designers for a number of years, it can be said that a serious effort in this direction was not made until the end of 1951. The success of the high speed pump and its rapid acceptance in the steam-electric power plant are due to the courage and conviction of both users and manufacturers to pioneer on a wide scale as soon as the first experimental pump proved itself successful.

Table of details of high speed b-f pumps already ordered for central station use

Size & Stages	Customer	Location	No. Units	Lb/hr	Suct. Press. PSI	Disch. Press. PSI	Temp. F.	RPM	Driver
6 in.-4	Public Service Elec. & Gas	Kearny Unit #8	1	610,000	285	2721	400	9000	Motor-Hyd. Cplg. & Gear
5 in.-4	U. S. Navy	.....	13	.....	...	....	...	7130	Turbine
5 in.-4	U. S. Navy	.....	13	.....	...	....	...	7130	Turbine
8 in.-4	Public Service Elec. & Gas	Linden #1	4	1,050,000	237	2311	362	8250	Motor-Gear Hyd. Cplg.
8 in.-4	Public Service Elec. & Gas	Linden #2	3	1,000,000	431	2729	425	8440	Motor-Gear Hyd. Cplg.
6 in.-4	International Paper Co.	Mobile, Ala.	3	565,000	605	1810	365	6500	Turbine
8 in.-4	Niagara Mohawk Power Co.	Huntley Station, Harriet, N. Y.	2	1,600,000	153	2720	270	7000	Turbine
8 in.-6	Cleveland Electric Illuminating Co.	Cleveland, Ohio	3	1,026,000	289	4303	340	7570	2 Turbines 1 Motor Gear & Hyd. Cplg.
8 in.-5	Metropolitan Edison	Portland #1	2	658,000	263	3570	364	6800	Motor, Gear & Hyd. Cplg.
6 in.-4	Tokyo Electric	Tokyo	4	480,000	163	2898	328	8500	Motor & Gear

Why Turbine Blades Have To Be Magnetic

STEAM TURBINE efficiencies increase with operating temperature, and since 1900, turbine temperatures and efficiencies have been climbing steadily at a rate of approximately 13 F each year. Figure 1 shows this increase, with maximum temperatures today at just over 1000 F. If this curve is extrapolated it will be seen that within a few years we should have turbines operating at 1200 F.

Now every increase in temperature presupposes a blade material strong enough to operate at the new temperature, and until recently, no suitable material has been available for operation at 1200 F. There have been materials that would keep their strength above 1000 F but none of them were able to retain their damping characteristics at the elevated temperatures.

Good damping is an essential characteristic for turbine blades. With no damping, blades would fracture in a few seconds under the vibrational stresses caused by repeated impact with the steam jets. Figure 2 illustrates the difference between a high damping material, such as a 12 per cent chromium alloy and the low damping characteristics of ordinary low carbon steel. This 12 per cent chromium steel, which exhibits high material damping and retains its strength up to 1000 F, has been in successful use for turbine blades since 1920.

Unfortunately, 12 per cent chromium steel does not retain its strength beyond 1000 F, and though there are several materials available that keep their strength above 1000 F, they do not have the necessary damping characteristics to make them suitable for use in modern turbines.

The problem, therefore, was to develop a new alloy that would retain its strength above 1000 F and at the same time would have high damping at these elevated temperatures.

To examine, on a trial and error basis, the almost astronomical number of alloys that could be made from metals available today, would have been impracticable, so Westinghouse Research Laboratories undertook a basic research project in order to be able to determine accurately the requirements of a suitable new material.

First they tried to discover the mechanism of damping in present blade materials. It was apparent that this was a useful mechanism, since the 12 per cent chromium steel had been used successfully for 30 years. Once this mechanism was clearly understood it was a comparatively simple matter to specify exactly the requirements for the new material.

They found that damping in the chromium steel was caused by an effect called magneto-mechanical hysteresis. Here is a brief explanation of its effect.

Each crystal of a ferromagnetic material is made up of very small regions called domains, in which the magnetic spins, i.e. the spins of the atomic electrons, which determine the magnetic behavior of the material, are aligned in one direction. The diagrams in Fig. 3 illustrate various arrangements for a small number of domains. Figure 3a represents an unmagnetized crystal.

On the application of a strong magnetic field in a horizontal direction, the walls of the domains move until all the magnetization is in the direction of the field, as shown in Fig. 3b. If a tensile stress is applied instead of a field, the magnetization would be in the direction of the stress, as in Fig. 3c, and if the stress is compressive the magnetization would be perpendicular to the direction of the stress, as in Fig. 3d.

During vibration, the stress alternates, and as a result the magnetization changes. This causes energy dissipation, as with any magnetic material (the area of a hysteresis loop shows the energy loss for each cycle of magnetization) and this is the reason for the high damping of the chromium steel.

As a result of these basic studies of the magnetomechanical effect, the desired properties of the new material could be determined.

First, a high strength alloy was needed, and it was known that such a material could be obtained by using a base material prepared from certain properties of nickel, iron, cobalt, and

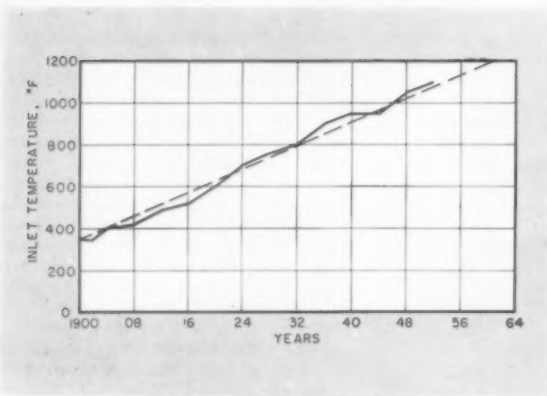

Fig. 1. Above: Graph showing how, with turbine efficiencies, steam inlet temperatures have steadily increased since 1900

Fig. 2. Right: Ping pong ball bounce shows damping. Fork at left is made of ordinary steel with poor damping. Fork at right is 12 per cent chromium steel with high damping

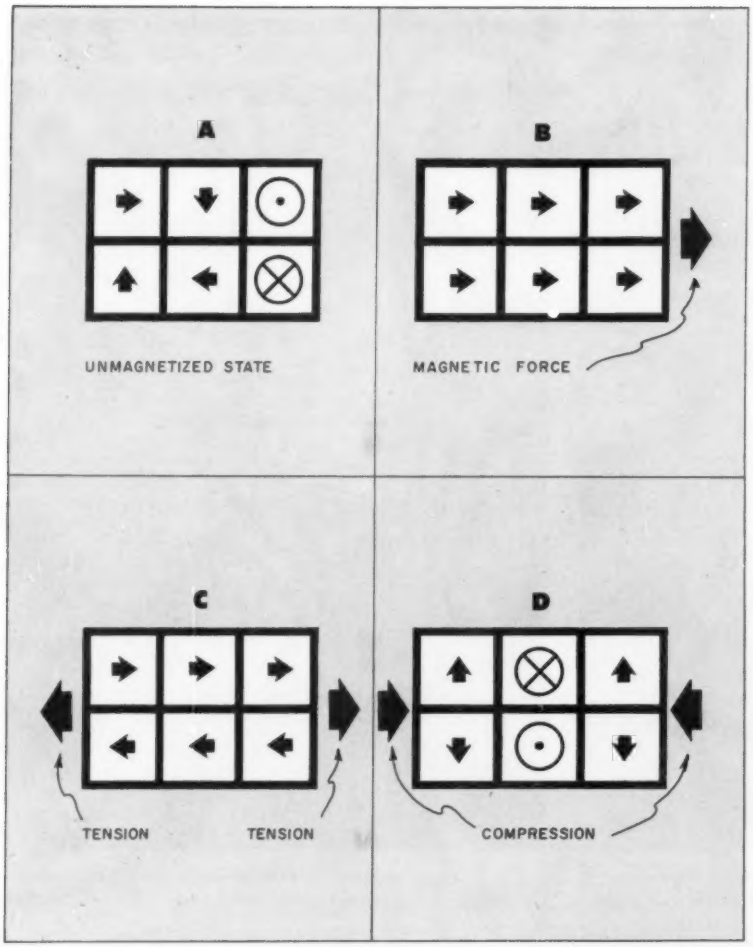

Fig. 3. Diagrams illustrating effect of mechanical stress on magnetism. a. Unmagnetized crystal. b. Horizontal magnetic field. c. Tensile stress. d. Compression

chromium. Secondly, high material damping was required, and this called for a material that was ferromagnetic, with a large irreversible magnetostriction, or, in other words, one in which a large amount of energy would be dissipated every time the direction of magnetization was changed by a reversing stress.

Thirdly, the Curie temperature had to be higher than 1200 F. The Curie temperature is the temperature at which the magnetic effect disappears. It will be seen from the previous remarks, that regardless of the mechanical strength, the damping effect depends on the magneto-mechanical effect, and if the magnetism were to disappear, the damping effect would disappear also. So it is essential that the full damping effect be maintained up to the maximum operating temperature of the blades.

The new alloy, which is made of nickel, cobalt, iron and chromium, with smaller amounts of five different elements, has properties at 1200 F similar to the 12 per cent chromium steel at 900 F. The ultimate tensile strength of the metal is about 100,000 psi at 1200 F, at which temperature the metal glows with a dull red heat. Its 100-hr creep-rupture life is of the order of 50,000 psi at 1200 F, and its damping capacity at 1200 F is about 10 times greater than the damping of similar super alloys at vibrational tensile stresses between 5000 and 10,000 psi.

Thus the development of this new metal clears the way for important advances in turbine design. One of the chief limitations on turbine design in recent years has been the lack of blade material that could operate successfully at the temperature of steam at higher pressures than those in use today.

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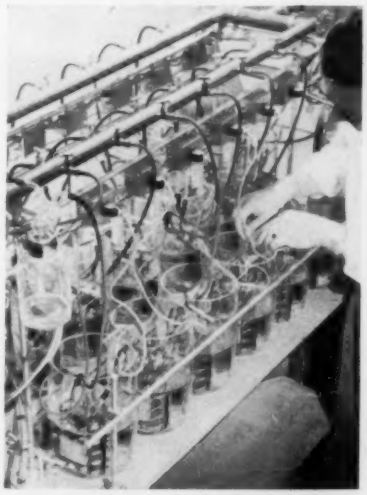
Research Continues on Fuel Cell

FUEL CELL is a battery that produces electricity directly from such gases as hydrogen and oxygen, and one of the many new devices under study at National Carbon Company's new basic research laboratories. *See illustration below.*

In ordinary batteries energy is obtained from metals and other substances in the form of charged particles. The flow of these particles is the electric current for flashlights, hearing aids, portable radios and so on. Recent research has shown the possibility of making a battery that will obtain its energy — its supply of charged particles — directly from gases present in the atmosphere, such as hydrogen and oxygen.

Dr. Robert G. Breckenridge, director of the new laboratories, indicated that a possible version would include two basic sections. One section would consist of layers of porous carbon and a liquid-paste caustic solution with a space in between. Oxygen would stream into the space, and its molecules would move through the submicroscopic tunnels and channels in the porous carbon. When the molecules reach the porous layer they form a film, and reactions take place which produce negatively charged particles. This is the electron-consuming or positive section of the battery. The other section, the electron-supplying, or negative, unit, is made in a similar way. It makes use of a stream of hydrogen gas which reacts to produce positively charged particles.

Potential applications of fuel cells are many. They could furnish auxiliary power in chemical plants where oxygen and hydrogen are by-products of commercial processes. They could also be used as power supplies for light buoys and remote stations.



Example of the oxygen or positive side of fuel cell. Another set provides the hydrogen, or negative, side of cell

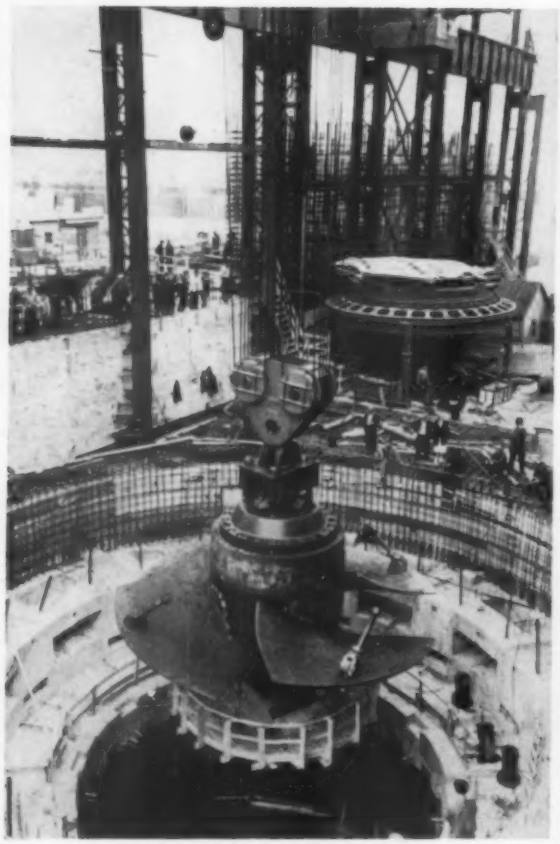


Fig. 1. Erection of unit at Kaliovka hydroelectric station on Dnieper River below Dnieprostroi, one of several new stations

Fig. 2. Linemen working on 400-kv Moscow-Kuibishev transmission line at Kuibishev hydroelectric plant under construction

Direct from Moscow, POWER ENGINEERING Editors Report Russian Power Progress

Soviet engineers develop electric power at accelerating pace in past 10 years; build hydroelectric plants of 3,000,000 kw capacity; long 400-kv transmission lines (may go to 600 or 800); study 200-kv d-c lines; build first 5000-kw nuclear power plant. Steam plants are minor factor; hydro predominates. Equipment is good; scientific work seems to be of high order

Fig. 3. Dnieprostroi hydroelectric station as it is now. Originally developed by Hugh L. Cooper of the U. S., plant was completely destroyed by Germans during war, since rebuilt by Russians

By ANDREW W. KRAMER
Editor
and
RICHARD H. MORRIS
Editorial Director
POWER ENGINEERING

PERHAPS it is presumptuous for anybody who has been in Russia for barely a month to even attempt to make an appraisal of any segment of the Soviet economy because it seems that, the longer one is here, the less positive one is about what goes on in this strange but intensely interesting country. The resident newspaper correspondents in Moscow know this and they are amusingly contemptuous of the fantastic reports some of the transient newspaper reporters send out after spending only a week or two here. Things are not exactly what they seem here, and it is unwise to draw too definite conclusions from what may only *seem* to be obvious facts.

Soviet Living Conditions

During the past few weeks while we have been in Russia, for example, there has been considerable criticism in the Soviet Press of certain areas of Soviet industry. There have been detailed reports of the shortcomings and inefficiency of railroad operations, citing idleness among workers and gross misuse of equipment. Collective farms as well as State-owned farms, it appears, are not meeting their quotas. Similarly, the fishing industry has been severely taken to task in the press for gross wastage and spoilage.

Now there may be two explanations of such criticism: 1, It may be valid and sincere; or 2, as some who had only brief residence in this country have suggested, it may be that these reports are issued only to impress the outside world that there is a free press in the U.S.S.R. Obviously, therefore, it is unwise to express opinions without really accurate knowledge of the underlying facts. There is little doubt that the areas subjected to this criticism are not going along too well, and the self criticism may indeed be sincere.

Most of the intelligent people we came in contact with admit that many things can be improved. They know that there is not enough of all kinds of food. Almost everybody knows that there is still a terrific shortage of housing, at least in Moscow and Leningrad, and they will tell you it will take many years to provide adequate housing. They know that nearly all commodities, particularly clothes, are very scarce, but at the same time they will point out that it is much better now than it was a year or two ago.

And the fact that their clothes are poor and often ragged does not worry them too much, because they know everybody else is in the same boat, and so they need not feel inferior or discouraged because of their old clothes. Like the people in London, the people of Moscow and Leningrad suffered tremendously during the war, but it was a collective suffering and in that they seem to find a certain measure of strength. Much of the gain they had made, up to 1941, was destroyed in the three years that followed. The siege of Leningrad lasted 900 days, and some 70,000 buildings were destroyed, including most of the old, treasured palaces and cathedrals. They have spent 10 years rebuilding these.

From our viewpoint, many things are deplorably bad. The housing — even their new housing — the food, the quality of much of the consumer goods, and especially the clothes — all are extremely poor by our standards. But we have little basis of comparison; we cannot know how much worse things were even four years ago.

Electric Power Progress Rapid

In many fields their advances are obvious. Much of their mechanical work — the design and construction of machines and particularly of electrical equipment — shows exceptionally good design and workmanship. With respect to electric power development, their progress is quite obvious. It is developing at a constantly accelerating pace, and in the field of long-distance high-voltage transmission their efforts will stand comparison with the best in the countries of the western world.

The Electricity Supply Ministry comprises four major divisions, as follows: 1, Operation; 2, Construction; 3, Supplies; and 4, Functional. The Electricity Supply Ministry is responsible not only for power generation and distribution but also for the manufacture of electrical machinery; construction of power plants; personnel, wages, finance; and for the supply of personal necessities of employees. In short, it controls all main and auxiliary services relating to the electricity supply, and no other Ministry has the right to interfere with its work.

Big Power System Plans

There has been tremendous progress in the extension of the Soviet power system during the last 10 years, particularly in the construction of very large hydroelectric stations and, as already mentioned, in the long-distance transmission of large blocks of electrical energy. Only recently, the second 400-kv transmission line between Moscow and Kuibishev was placed in service.

Kuibishev is now under construction with two hydroelectric units installed. Ultimately this station on the Volga will have a generating capacity of 2,100,000 kw. This, however, is only one of several large stations on the Volga River to be completed during the sixth 5-year plan.

Main target of the sixth 5-year plan is the development of a grid system covering the entire European territory of the Soviet Union. This, indeed, is the most acute problem of the Soviet electricity supply. The principal units included in this system are the super-hydroelectric stations at Kuibishev, Stalingrad and Gorkov, all of which are in various stages of construction. The 400-kv Moscow-Stalingrad, and Moscow-Kuibishev lines and several other future 400-kv lines will form the backbone of this grid system. When completed, this system will interconnect a total generating capacity

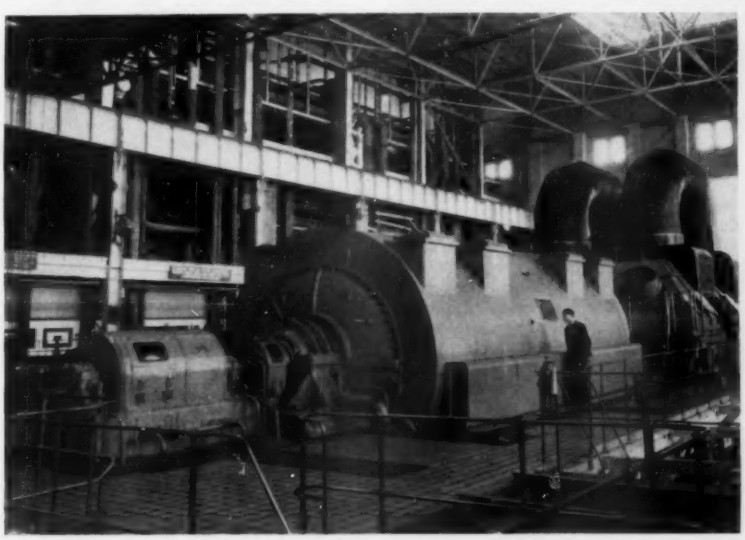


Fig. 4. Here is shown a view of a 100,000-kw, hydrogen-cooled steam turbine generator at the Tula District Cherepetskaya steam station. Note the details of appearance and construction

Fig. 5. Electro-physical Research Center of U.S.S.R. Academy of Science near Moscow, contains 10,000,000,000 electron-volt accelerator, world's most powerful

of some 30,000,000 kw all together.

The European Grid system of the Soviet Union, however, is only part of the complete plan for hydroelectric development. Extremely large hydroelectric plants are also planned for the Eastern half of the USSR, and some stations are now under construction. The Angara and Enysei Rivers are exceptionally favorable for hydroelectric development. Plants to be constructed on these two rivers alone will total 10,000,000 kw.

One station on the Angara, alone — the huge Bratsch hydroelectric plant — will have a capacity of 3,200,000 kw. This is now under construction. Another 3,200,000-kw station, on the Enysei River, will also be completed during the sixth 5-year plan. This is the Krasnojarsch Station.

May Go from 400 to 800 kv

Construction of these large hydro plants in Siberia is a strong stimulus for the creation of a single Siberian power system that will consolidate all hydro stations on the Angara, Enysei and Ob rivers with the thermal stations in the Irkutich-Cheremhovsch region and elsewhere.

Interconnection of this Siberian system with the systems of the Urals and of the European part of the Soviet Union will finally lead to a single interconnected system covering the entire Soviet Union. This will require transmission lines well over 2000 km (1242.8 miles) long and the transmission voltage will have to be raised from the present 400 kv to 600 or 800 kv. Development and research are proceeding in this direction.

Great amount of research and experimental work is in progress in the development of methods and equipment for these high voltage transmission systems, and very elaborate tests are made on the lines before they are placed in service. In the case of the Moscow-Kuibishev 400-kv line, which operates at 50 cycles, the characteristics were also measured at various other frequencies from 40 to 130 cycles. This work involved the simultaneous use of 60 magnetic oscillographs and 30 cathode ray oscilloscopes. When operated at 310 kv, the switching transients on this line rose to twice normal voltage without reactors. The line was placed in operation in April of this year and now operates at 400 kv. It is a 3-conductor, bundled line.

High-Voltage D-C Systems

With the view of facilitating the long-distance transmission of power, the Ministry is engaged in extensive research on the development, not only of very high-voltage a-c systems but also of high-voltage d-c systems. An experimental d-c transmission line, transmitting some 30,000 kw at 200,000 v, has been operated for some time quite successfully, except that the mercury-arc rectifiers used are not satisfactory for normal service. An intensive study of semi-conductor types of rectifiers is being made for this purpose. The development of suitable d-c circuit breakers is also hindering the development of high-voltage transmission.

Claim First Nuclear Power

Of great interest and of particular pride to the Russians is the 5000-kw nuclear power plant about 80 miles south and a little west of Moscow on the Okra River. This station supplies the town of Obinskaja, and is claimed by the Russians to be the first atomic power station in the world. It has been in operation a little over two years. Of course, electricity was generated from nuclear power in the U. S. at Idaho Falls, at the AEC testing station, as early as December 1951, but this was purely a demonstration, as were other small generating units built in connection with other plants since that time. Actually the Russians are correct: this is really the first nuclear power plant built primarily for the purpose of supplying electric power to a community. The reactor is a pressurized water reactor, of rather unnecessary complexity, and is quite inefficient from a nuclear as well as a thermal standpoint.

Much more impressive in the nuclear field than this first 5000-kw nuclear power station is the new syncroproton accelerator at the Electro-physical Research Center of the USSR Academy of Science, located at the northern end of the Moscow-Volga canal 80 miles from Moscow. This is the most powerful accelerator in the world, rated at 10,000,000,000 electron-volts. This is a tremendously impressive machine and gives the Soviets a powerful tool for further investigations in nuclear science.

Russian Science Good

On the whole, scientific development in the Soviet Union is of a high order. Their instrumentation is excellent, the design of their scientific equipment is extremely modern and seems to involve a high order of precision. Some of this equipment seems to have been copied from equipment in other countries, though they scarcely ever will admit it.

When we were shown the turbines being installed at Kuibishev, we referred to them as Kaplan turbines. "Oh, no!" our guide corrected us, "these are ——— turbines; they were developed by our engineers!" The fact remains they are still Kaplan turbines!

Russians Want to Excel

This desire of the Russians to excel is astonishing. It is found everywhere: in music, in the ballet, in sports, in scientific development, in virtually everything they do. They constantly compete with each other. This spirit of competition is illustrated in the construction of their subways — their Metros. The Moscow subway was built years ago, though it is steadily being extended. The beauty of its stations, its clean-

Fig. 6. First commercial 5000-kw atomic power plant, near Moscow, has been in operation over two years, but prior U. S. experimental units generated power

liness, its beautiful lighting and its excellent railroad equipment has not been exaggerated. It is a work of art and a highly utilitarian system.

Recently, however, Leningrad built its first subway. It was begun only 5 years ago, yet the first 14-mile section was placed in operation in November, 1955. It is a much deeper subway than Moscow's because of the swampy ground of Leningrad, and was more difficult to build. But Leningrad also set out to make its subway more beautiful than Moscow's, and those of us who have seen them both are inclined to agree that the Leningrad Metro is even more beautiful, and certainly just as clean and well operated, as the one in the USSR capital city.

Conclusions Difficult

In conclusion, we want to emphasize again that no observer spending only a few weeks or a month in Russia can set himself up as an authority about everything in the Soviet Union, or even small segments of its territory or economy. With regard to plants and factories, for example, we saw many that were far inferior to similar plants in the U. S.; but it would be unwise to draw conclusions from this fact, because there are a number of large "restricted" areas in various parts of the country that are completely closed to foreign visitors. There is no doubt that these areas contain many industrial establishments which may be far better than those we have seen.

Russian Work and Wages

On the whole, we found the Russian people friendly and responsive. Some of their ways annoy western visitors; but they are *their* ways and we cannot judge them by our own. Women do a great deal of manual labor, but there is no stigma attached to this and they seem cheerful about it. We saw many women at work in foundries — making cores, loading molds, running machines, and all working hard. In one shop, most of the women were on piecework and they never looked up.

The average wage is low — from 800 to 1000 rubles a month for ordinary skilled workers. Yet it takes 400 to 600 rubles to buy an ordinary pair of shoes and 1100 rubles for a poorly tailored suit. Thus the Soviet worker works over a month to buy a suit.

Rent, however, is very low — 80 rubles a month for an ordinary flat. And of course, medical service, hospitalization and dental work costs nothing. Transportation is cheap, ½ ruble or 50 kopeks on the Metro. Furthermore, almost everybody in a family works, so they all bring in wages. And since they eat at home, together, their food is not a burden even if it is expensive. They spend money freely. Almost any desirable commodity is sold out at once.

Cultural Interests

This is particularly true of books. As the Editor of the *Soviet Union* told us, "In the U. S. a *best seller* will sell 100,000 copies, perhaps even 200,000 copies. But in Russia that is nothing. Here an ordinary book will sell 3,000,000 copies, and the edition will be completely sold out in a week."

The Russians are avid readers. In addition to their own authors, they read all the American and English classics.

It is curious that a nation which glorifies the worker — the toiling masses as they call them — in every speech, every statue, every painting, should place so much emphasis on culture. It is not the worker who receives the high salaries, but the artists, the musicians, the people of the theatre and the ballet, and the scientists.

These are the highest paid people in the land and it is reported that their living standards are high. Russia is indeed a land of paradoxes.

Fig. 7. Step-up transformers at the Tula District Cherepetskaya steam-electric station; secondary voltage 220,000; these would be big transformers anywhere

Fig. 1. President Schuberth greets some of the American delegates, Dr. Molineaux of the ASCE, Dr. Keachie of U. of Cal., Dr. Sorensen of Cal Tech and Bob Allen of Milwaukee

Fig. 2. E. Kothe, "grand old man" of the VDI (left) with American society representatives, Dick Morris of the AIPE, Bob Bacon of the ASME and Gen. Reimel of the EJC

German Engineers Hold Centennial

World-wide engineering societies send delegates to 100th Anniversary of VDI, the Verein Deutscher Ingenieure or German Engineers Association. Disbanded during the war, headquarters confiscated and membership records destroyed, association was permitted to reorganize in 1946, now boasts 32,000 members

By RICHARD H. MORRIS
Editorial Director
POWER ENGINEERING

BERLIN, a city divided, with the heart of the "old city" strangling in Communist hands and the "new city" a free island in a sea of Red, was recently the Mecca for engineers from scores of countries where engineering societies are permitted to exist. The year 1956 includes two anniversaries which mean much to German engineers — the conclusion of a century and of a significant decade.

Growth, Eclipse, Rebuilding

On May 12, 1856, twenty-three young engineers, while on an excursion to Alexisbad in the Harz Mountains, organized the Verein Deutscher Ingenieure, which the world knows as the VDI or German Engineers Association.*

On August 16, 1946 permission was granted by the British zone authorities of Berlin to again reorganize the association. Disbanded long before the war, its headquarters building confiscated, membership records destroyed, the site of its former activities and half of its territories in enemy hands, only Herculean efforts by a handful of men made the reorganization possible.

The story of growth, decline, eclipse and rebuilding is well told by membership figures. Inside of a year from 1856, the original 23 members had grown to 300 in seven branches; at 10 years, 1300 members; at 25 years, 4000 members and in 1931 some 30,000 members in 53 domestic branches and three in Austria.

After a lapse of 15 years a second start was made, with one man, a chair and a desk in a rented office. Nine years later saw the membership rolls climb to 30,000 and at the date of the present Centennial, 32,000 members were listed in 38 branches.

Essentially the VDI aims at uniting German engineers and directing their activities for the advancement of industry. Special fields of endeavor covered since 1858 include: boiler control; coal research; patent laws; V-threads for screws and nuts; employment of technicians in public works; coöperation with technical universities; testing of materials; standardization; and exchange of know-how with foreign countries.

In 1916 the German Association for Technical and Scientific Societies (Deutsche Verband Tecknisch-Wissenschaftlicher Vereine) was formed under VDI auspices. This gave a start to the Standard Committee for Mechanical Engineering, which rapidly developed into the Normenansschus der Deutschen Industrie or the well known DIN.

How VDI Operates

Basically the operations of the VDI are carried out by five main and 21 special committees. The main committees consist of: Ethics and professional problems; training and education; management and engineering; the history of engineering; and legal or patent laws. Special committees are concerned with technical phases common to all industries or with special branches of industries such as textile, automotive, aviation.

Some 4000 engineers from Germany and scores of foreign countries thronged the Centennial meetings at the Festival Hall in Berlin Radio Center. Many of the foreign visitors were official delegates of engineering societies from all countries where such activities are permitted.

From the United States these included R. H. Morris for the American Institute of Plant Engineers; R. H. Bacon for the American Society of Mechanical Engineers; Dr. Molineaux for the American Society of Civil Engineers; Dr. Sorensen for the American Institute of Electrical Engineers; Bob Allen of the Milwaukee Engineers Association; Dr. Burt for the American Society for Engineering Education; and General Stewart E. Reimel for the Engineers Joint Council.

Dr. Gilbreth Honored

Dr. Lillian M. Gilbreth, probably the best known and revered American engineer in Germany, was honored by the award of the VDI Sign of Honor on the occasion of the Centennial. The citation was "for outstanding research into motion study for finding the 'one best way' to accomplish production tasks and for carefully fostering human relations and coöperation in working groups."

Industrial engineering is at the moment foremost in the thoughts and talk of industrial men and of

* Address of the Verein Deutscher Ingenieure is: Prins-Georg-Strasse 77/79, Dusseldorf, Germany. Copies of the papers can be obtained from the society but are not available in English.

Fig. 3. All sessions were held in the Festival Hall at the Berlin Radio Station
Fig. 4. (Upper right) Delegates viewing the scrolls, gifts and paintings presented to the society, including a medieval text on Mining and Metallurgy, dated 1657

students. Dr. E. C. Keachie, a professor of the University of California and at present Fulbright Guest Professor at the Tecknische Hochschule in Darmstadt, gave a special lecture at the Technische Universität. The main program for this Centennial meeting was grouped in four major sessions covering as a rule in general terms and historical developments:

Highlights of Program

1. Research and Development starting with a review of Nuclear Energy by Humbach, followed by a discussion of the influence of materials on engineering developments by Schmid and the application of process techniques in the development and manufacturing of new products by Riess.

2. Design and Construction in three phases: the practical aspects; use of model tests for design purposes, by Peppler; the advantages of and necessity for lightweight construction, by Kirste; and the present trend toward both artistic and functional design for (a) consumer products (b) and purely technical equipment, by Bobek.

3. Manufacturing: opening with a review of fabrication principles, by Kienzle, with an analysis of the flow of materials as the first step in automation, by Kienbaum, followed by a philosophical and practical discussion of automation by Steeger.

Steeger's conclusions are: (1) automation is a necessity if advances in power are to be utilized in meeting the needs of the world's increasing population; (2) that American developments form interesting studies not too well adapted to European conditions; and (3) the resulting change in the social structure and employment practices will not mean unemployment of engineers, for there is a shortage of 40,000 now and the increased need of experts to market, service and maintain automation installations will further increase the demand.

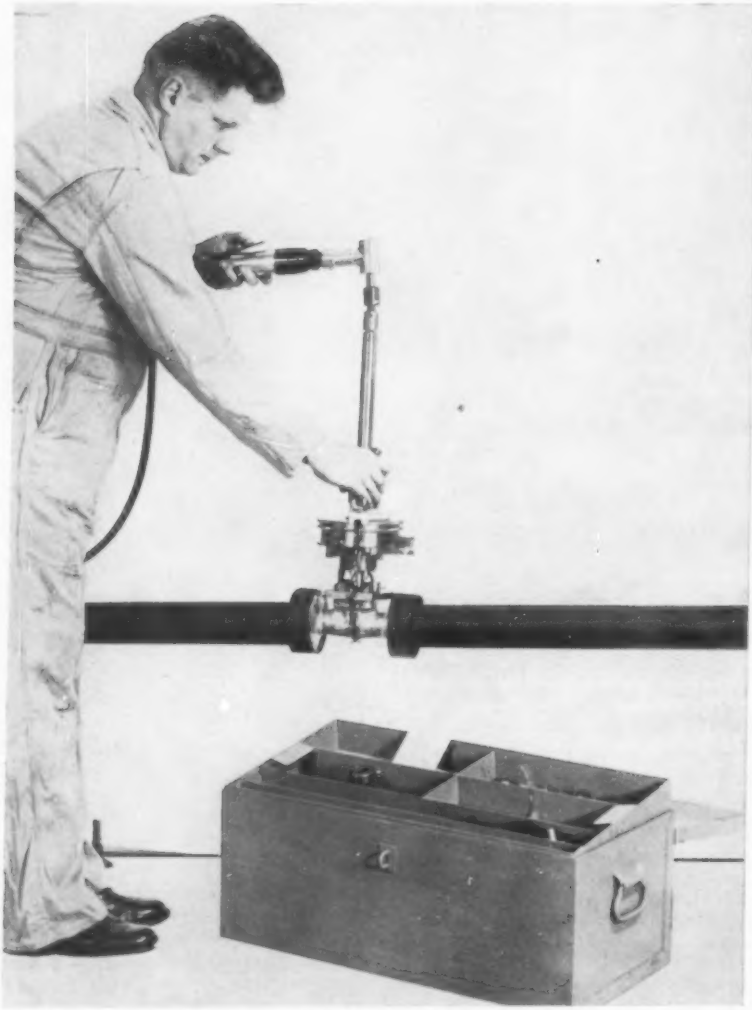
4. Man and Economy was also in three phases: the engineer and the distribution of goods, by Jakopp; future leadership and the development of executive ability, by Schlicht; and legal aspects of industrial patent protection, by Radt.

The program was rounded out by three major lectures of a more or less philosophical nature: The interrelationship of natural science and technology, by Vieweg; technological trends particularly as concerns the training of the coming generation, by Finkelnburg; and man and his technology, by Pfender.

The Grasshoff medal, the society's highest award for distinguished service, was awarded to Dr. Schmidt, professor of thermodynamics at the Technical University, Berlin, who thus joins the ranks of such men as Linde, Maybach, Miller, Junkers and Lungstrom — all famous names in this fundamental and important field.

Fig. 5 (Above) Dr. Lillian M. Gilbreth was the American engineer selected to receive the VDI Sign of Honor for outstanding research in motion study and human relations. Her arm is in a cast from a recently-sustained fracture

Fig. 6. Dedication of "The Engineer," reproduction of the statue that for years symbolized the engineering profession in the old VDI headquarters building



Operator using new motor-driven valve grinder to reface seat of valve in line

Table showing comparisons of costs for valve maintenance by various methods, from a number of companies surveyed

1. Average total time in hours required to maintain a defective valve by different methods of valve maintenance.	*Hours*
A. Removal of old valve and replacement with new valve.	7¼
B. Removal, repair and replacement of old valve.	9¼
C. Reseating or grinding of old valve in the line.	3
2. Percentage of respondents who stock replacement valves.	75%
3. Average dollar value of replacement valve inventory.	$3823.00
4. Respondents' estimated average costs of different methods of valve maintenance.	
A. Total cost of replacing valves	$6580.00
B. Per valve cost of replacement	731.00
C. Total cost of repairing valves	100.00
D. Per valve cost of repairing valves	5.00
E. Total cost of reseating valves in the line	46.00
F. Per valve cost of reseating valves	3.50

This One-Man Power Tool Grinds All Size Valves in the Line

SAVINGS as high as 400 per cent on labor, increased production, fuel savings and power gains are claimed as some of the unusual benefits resulting from the use of the new motor-driven valve reseating grinder shown here, a recent survey of over 1500 utilities revealed. One man, it is stated, using the versatile new machine, can regrind any globe or gate valve from ¼ in. to 12 in. without removing the valve from the line.

Through the use of a new high speed motor and recently developed abrasive cloth grinding elements, the new machine is designed to grind the seat of any valve regardless of material hardness. The grinding elements, made in the form of cones and segments, are mounted on various size rubber coated grinding heads. By changing these grinding heads, the same machine can be used on various size valves.

Since one man using the new machine can grind any valve right in the line, the manufacturer says that need for 3 or 4-man crews to remove and replace defective valves is completely eliminated. Further, the machine reduces or does away entirely with costly replacement valve inventories, it is claimed. The precision-built machine guarantees accuracy by refacing irregular valve seats from the same "reference point" that was used by the manufacturer in machining the original seat. Strict adherence to the original "reference point" is intended to make the reground valve as tight as new.

Information, in the accompanying table, tabulated from the returns of the recent survey, is evidence that most firms using valves are paying much more in wages, lost production, fuel and valve replacement costs every year than the cost of a new motor-driven valve reseating grinder.

This new motor-driven valve reseating grinder is available in compact kit form in three basic models for globe and gate valves.

Want More Information?
For further details of this valve grinder, write the editor; or jot VALVE GRINDER on the prepaid return post card elsewhere in this issue and mail it to us.

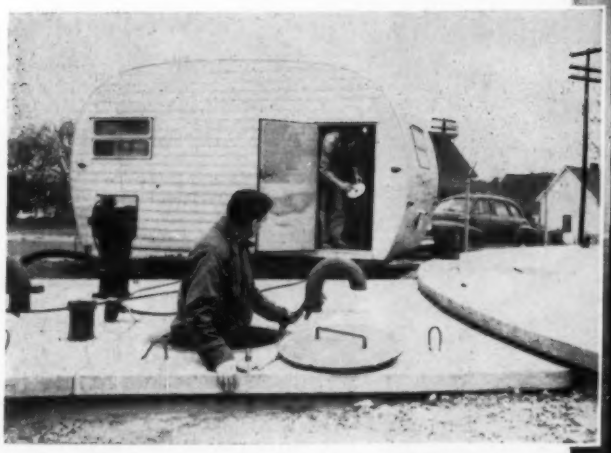
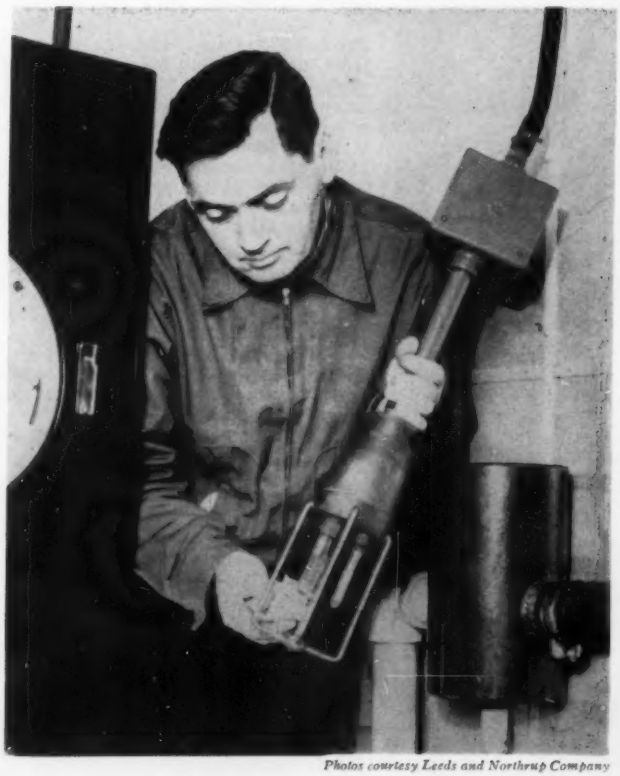


Fig. 1. One of Charlotte's lab trailers stationed at plant waste water outlet for 24-hr effluent pH test; plants using over 40,000 gal./day tested every 90 days

Fig. 2. (*Right*) Inside trailer, low and high range flow recorders show at panel top; Leeds and Northrup pH indicator at bottom right sends signal to recorder

Trailer-Lab Checks Plant Waste Effluents

Water Department of Charlotte, N. C., has two new trailers especially equipped with instruments that make automatic 24-hour tests of all industrial plant effluents every 90 days. These mobile laboratories keep an eye on pH of discharged wastes



Photos courtesy Leeds and Northrup Company

Fig. 3. (*Above*) Operator checks a chart record of pH variation throughout complete 24-hr test period to determine if effluent exceeded limit of 6–9 pH

Fig. 4. (*Left*) Electrode assembly of pH recorder has extension cable to reach plant effluent line. Measuring element includes temperature compensator

Coal Pipeline Nears Completion

By V. D. HANSON *

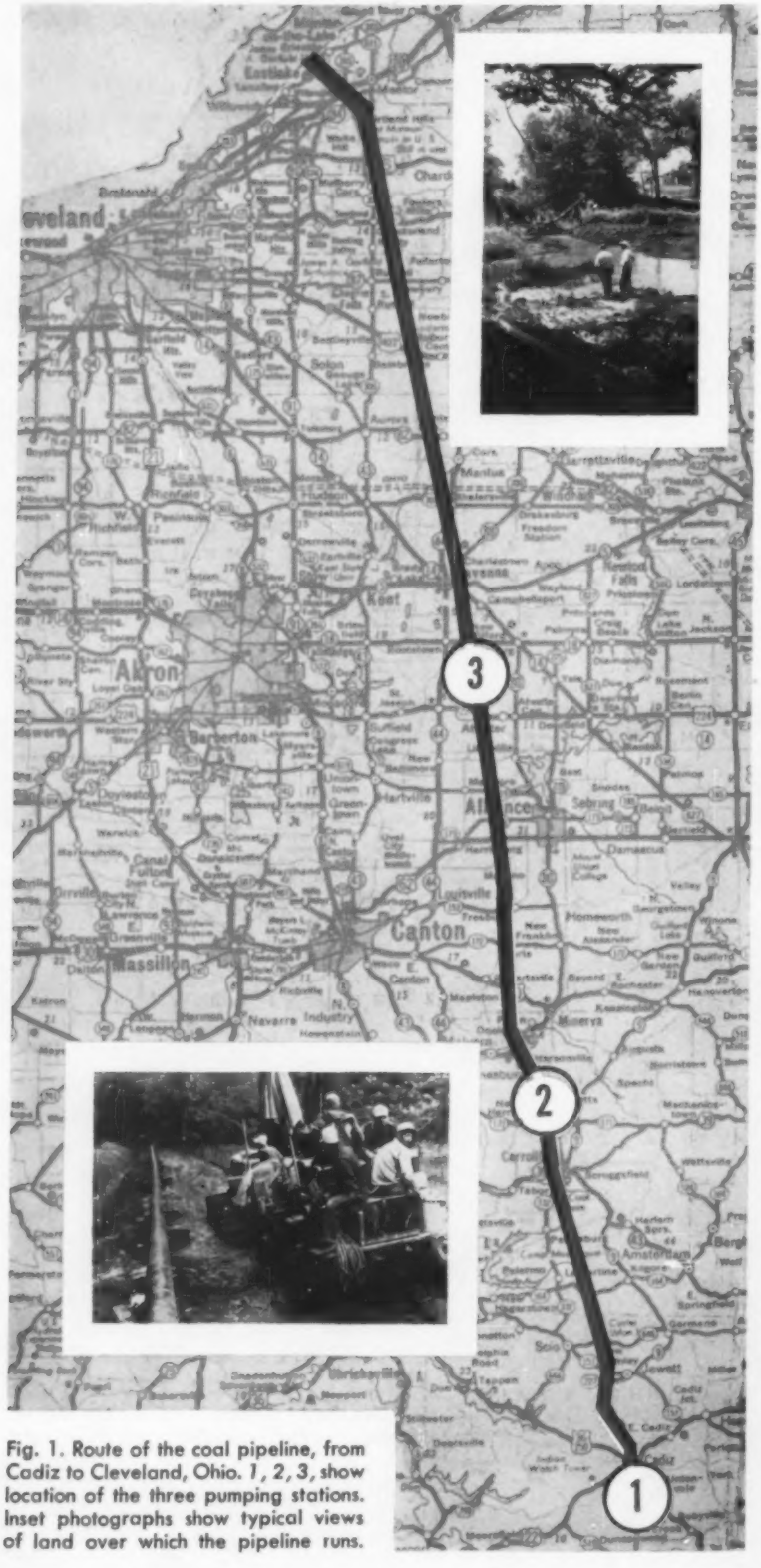


Fig. 1. Route of the coal pipeline, from Cadiz to Cleveland, Ohio. 1, 2, 3, show location of the three pumping stations. Inset photographs show typical views of land over which the pipeline runs.

IN 1949, THE MANAGEMENT of Pittsburgh Consolidation Coal Company, in an effort to reduce the cost of coal to the consumer, decided to investigate cheaper methods of transporting their product.

For hauls of 100 miles or more, freight represented 50 per cent of the cost of coal to the customer, so any saving in the cost of transportation would mean a corresponding saving for the customer.

At this time the utility companies were, and still are, in the midst of a huge expansion program. Cleveland Electric Illuminating Company wanted a long-term supply of coal to be delivered to their Eastlake Station on the lake. Increasing freight charges on the lake shipments to Cleveland encouraged the search for an inland coal source. CEI was already buying coal from the Hanna Coal Co., a division of Pittsburgh Consolidation, and this was found to be a suitable source for a long-term supply. The Hanna Co.'s location was about 100 miles from the point of delivery at Eastlake Station.

Choice of Method

It then became a matter of choice as to what method should be developed as an alternate means of transportation. Preliminary paper studies clearly indicated that a pipeline carrying a coal water slurry offered appreciably greater potential savings over other possible modes of transportation. It could be argued that since present coal cleaning practices involve the making of a slurry, dewatering and finally drying, the only effect of a pipeline would be to increase the distance between the slurry making and dewatering and drying steps.

However, as we were to learn, there is quite a long, rough road between fact and fancy. In our case it took six years and some $2,000,000 to develop this road.

Then followed a long series of pilot plant tests, followed by experimental work on a large scale Demonstration Plant, using various pumping velocities, size consists of coal, slurry concentrations and pipe diameters. Information was also obtained on the best type of pump to use for this work, the amount of abrasion to be expected on the high pressure pumps, ways in which corrosion could be reduced, solids distribution in the pipeline during flow, particle degradation in dewatering, and other information necessary before the sound economy of the project could be established.

By the spring of 1953 all of the technical problems had been resolved

*Chief Mechanical Engineer, Pittsburgh Coal Company

and the data were available to define the operating costs of a commercial coal pipeline. The management of C.E.I. was apprised of the status of the development. Again they were very enthusiastic about the results and the capacity figure for a commercial line was fixed. Consequently, by the end of 1953 Pitt-Consol engineers had completed the design and economic evaluation of a coal pipeline to run from Cadiz, Ohio, to Eastlake Station of the C.E.I. system.

As a final check, it was mutually agreed by the management of both companies that an outside engineering firm familiar with pipeline construction should be retained to look over the figures. A Feasibility Report submitted by a well-known pipeline engineering firm in May of 1954 confirmed the adequacy of the design and estimated construction and operating costs.

Decision in 1954

In August of 1954 the decision was made to build a coal slurry pipeline between Cadiz, Ohio, and the Eastlake Plant, a distance of about 110 miles. A contract was signed with C.E.I. to supply their Eastlake Station with 1,300,000 tons of coal a year for a period of 15 years. It was further decided to retain the same engineering firm that made the feasibility report to work out the necessary specifications for constructing the pipeline and pumping stations.

However, Pitt-Consol felt that due to their experience in coal preparation they would handle the specifications on the Slurry Preparation and Dewatering facilities.

The initial effort of the engineering firm was to lay out a specific route for the pipeline based on aerial survey maps. This route is shown in Fig. 1. Booster station locations were chosen so that each would have the same discharge pressure. The three stations were to be located as follows:

No. 1 — Close to the preparation plant near Cadiz.

No. 2 — Approximately thirty miles north near Carrolton, Ohio.

No. 3 — Another thirty miles further north near Atwater, Ohio.

The main pumps are high pressure, piston type pumps driven by an electric motor through a fluid clutch. Two pumps will be operating with one on standby so that a routine maintenance schedule on replacement of the pump internals can be set up. By means of the fluid clutch the pump speed is automatically regulated to compensate for the wear of the internals. In this way a constant throughput can be maintained as the volumetric efficiency decreases. When the efficiency of a pump reaches 80 per cent, it will be taken off stream and replaced by the standby. In addition controls have been provided so that the preceding station will automatically pump through any booster station where a power failure might occur.

By July of 1955 the specifications for the laying of the pipe had been completed and invitations to bid were sent out from the field office to various pipeline contractors. Approximately 15,000 tons of 10¾ in. O.D. pipe were ordered and delivery schedules arranged to permit laying of some pipe before the end of the 1955 construction season. A pipeline contractor was selected in the latter part of September and work began almost immediately. As a result, 30 miles of pipe were laid, tested and approved by the first week in November.

To avoid the problem of freeze-ups during the winter months, the pipeline will be buried to a depth of at least 4 ft for its entire distance. Fig. 2 shows the machine used to prepare the ditch into which the pipe is laid.

Fig. 2. Pipe will be buried at least 4 ft all the way to avoid danger of freezing

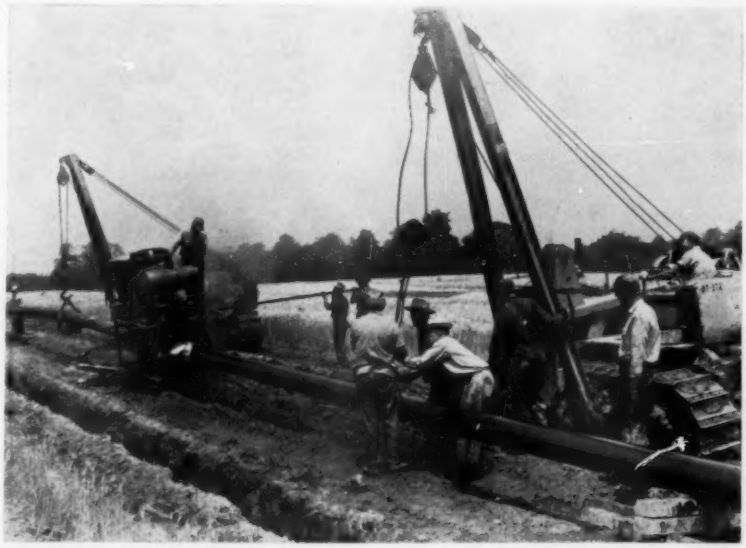


Fig. 3. This machine removes rust and dirt and applies primer in one operation

In this type of country this machine averages 2 to 2.5 miles a day.

Pipeline joints will be welded. Extreme care is necessary in the preparation of the material at the joint to be welded. The work is done by two welders working simultaneously on opposite sides of the joint. As one welder adjusts the amperage another laborer wire-brushes the face of the joint. The pipe sections are about 40 ft in length.

Two welders apply the stringer bead. This is probably the most critical pass in the whole welding operation because there must be 100 per cent penetration and the weld must be absolutely free of slag deposits. These welders are followed by the fill-in welders whose job it is to put

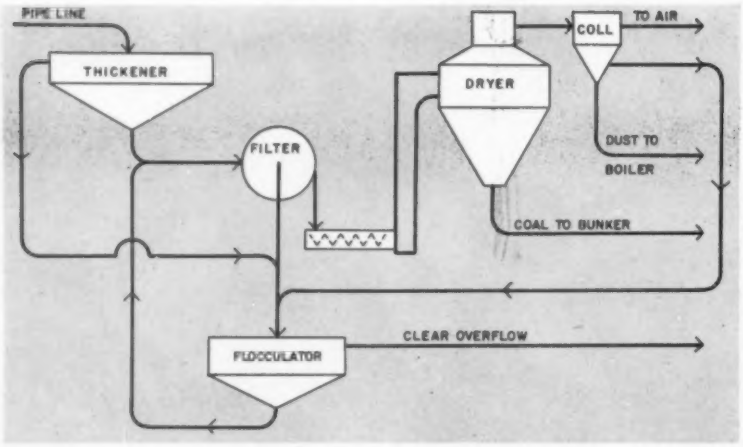


Fig. 4. Simplified flow diagram of the Dewatering Plant at termination of pipeline

in the rest of the metal necessary to complete the weld. Next a coating is applied to protect the outer surface of the pipe from corrosion.

First step in the coating operation is to scarify the surface to remove rust and dirt, and then apply a primer which provides the bond between the metal and the final coat of enamel. A machine does the operation all in one step, as shown in Fig. 3.

Then another machine simultaneously applies the enamel and final wrap of glass cloth. The purpose of the glass cloth is to evenly distribute the enamel over the periphery of the pipe and to bring any occluded air to the surface.

From here it remains only to lower the pipe, back fill the ditch, clean up the area and you have a pipeline.

The problem of locating the Dewatering facility was complicated by the fact that it had to dovetail into the Eastlake Plant and yet not interfere with any of the expansion that was planned or in progress. However, by working in close cooperation with the C.E.I. engineers a satisfactory site was chosen and a construction contract awarded in June of 1955.

Figure 4 is a simplified flow sheet of the Dewatering Plant. The pipeline slurry is discharged into two 90-foot thickeners where it is thickened to about 60 weight per cent solids. The thickened slurry is then pumped to vacuum disc type filters where the moisture content is reduced to around 20 per cent. The filter cake is charged into a standard flash dryer and the dried product is then weighed and discharged into a storage bin.

From the storage bin it is conveyed by belt into the regular fuel bunker of the power plant. Both dry and wet type dust collecting equipment has been installed to insure a clean discharge from the flash dryers. The final cleanup of the water prior to discharge is accomplished in an 85-ft flocculator. It should be emphasized that in this plant, as in the Slurry Preparation Plant, standard equipment common to coal cleaning operations has been used.

One of the biggest problems associated with the Slurry Preparation Plant was providing suitable facilities for the storing and subsequent easy recovery of feed coal for the pipeline. The pipeline will operate 24 hours a day, seven days a week as compared to two or three shifts per day, five days a week for the Cadiz Plant. For this reason the Slurry Preparation Plant must prepare pipeline feed at a rate in excess of 300 tons an hour during the period when coal is available from the Cadiz Plant. Since the pipeline only requires about 150 tons per hour, the excess must be stored and then recovered when the Cadiz Plant is not operating.

Figure 5 shows the flow diagram of the Slurry Plant in simplified form. Clean 3/8 in. x 0 coal, which is a Deister table product, is pumped as a slurry from the Cadiz Plant to a set of screens in the Slurry Preparation Plant. The undersize from the screens, which is suitable pipeline feed, goes directly to drag tanks. The screen oversize is either crushed and sent to the same tanks or can be pumped directly to a storage pond. If it is crushed, the excess coal from the drag tank discharge is sent to a second storage pond. The very fine coal that overflows with the water from the drag tanks is sent to a third storage pond.

The reason for storing the size fractions separately is to avoid the size segregation which would occur if all fractions were sent into one pond. In this way the dragged solids and the fine solids can then be recombined in the same ratio as existed in the feed to the drag tanks. Also, the reduction of the screen oversize can be accomplished without overloading the crushers with fine coal.

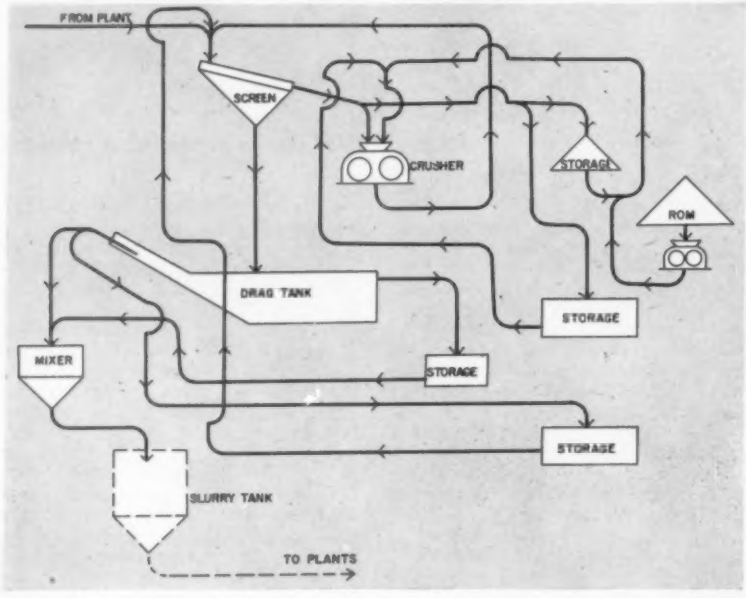
The final slurry is made up to the proper concentration by adding water to the pipeline solids in this tank. The tank is equipped with controls which continuously measure concentration and automatically add the proper amount of water. Thus, it can be seen that the greatest care has been taken to provide a pipeline feed of the proper size consist and solids concentration.

The time elapsing between introduction of slurry to delivery will be about 30 hrs.

Total cost of the pipeline will be approximately $10,000,000.

Pipelaying was completed about the middle of last month, and final tests are expected to be made on the line late this year. The schedule calls for coal delivery to begin early in 1957.

Fig. 5. Flow diagram of Slurry Plant, in which coal is prepared for pipeline feed



1956 Power Show Returns to New York

New Coliseum in New York City, with special facilities for handling such expositions, will house 1956 Power Show, officially 22nd National Exposition of Power and Mechanical Engineering, November 26 to 30, under auspices of ASME

AFTER a 4-year absence, the Power Show returns November 26–30 to New York, to the facilities of the new Coliseum. As heretofore, it will be held under the auspices of ASME.

Plans filed with the management reveal that many advances in engineering design are being made ready for release in November, notably such as utilize improved materials, or introduce innovations in instrumentation, automation and testing.

Power Show week in New York, aside from the exposition, will include the 76th annual meeting of ASME and the annual meeting of the American Rocket Society.

Steam Equipment

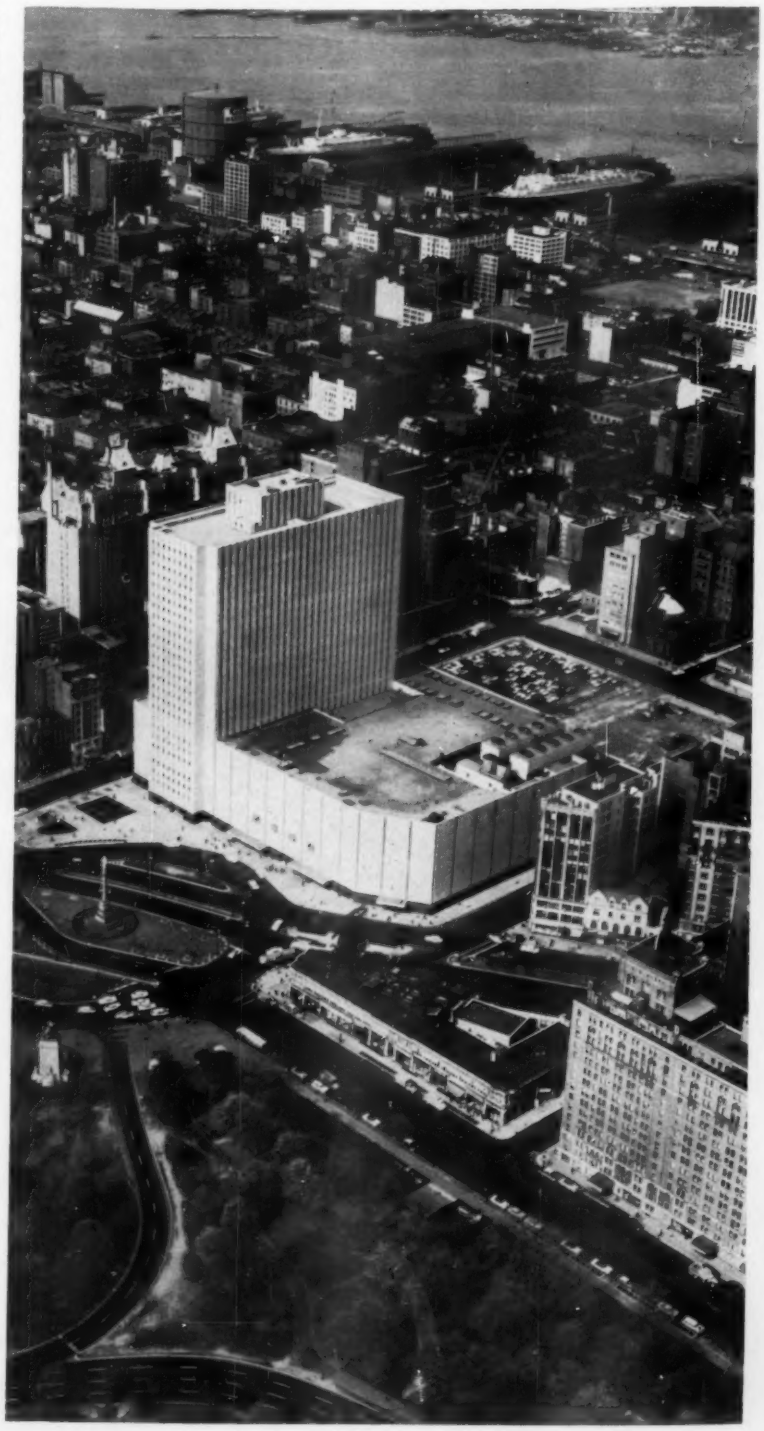
Equipment for production and use of steam will constitute a large proportion of the exhibits at the Coliseum. There will be a comprehensive display of package boilers, as well as components for high-power steam generators, which are individually designed. Steam engines, turbines and turbine generators will represent the field of prime movers.

Components used in steam generation will include: burners, refractories, insulation, sludge solvents, dust control apparatus, gas scrubbers, tubing, pipe and pipe fittings and supports, flexible and expansion joints, seals and packings, valves and valve controls, traps, pumps, fans and blowers, among others. Many exhibitors will offer equipment and supplies for installation and maintenance of plants, such as packing and gaskets, tube expanders and cleaners, gas analyzers, gages and indicating instruments of many kinds.

Atomic Section

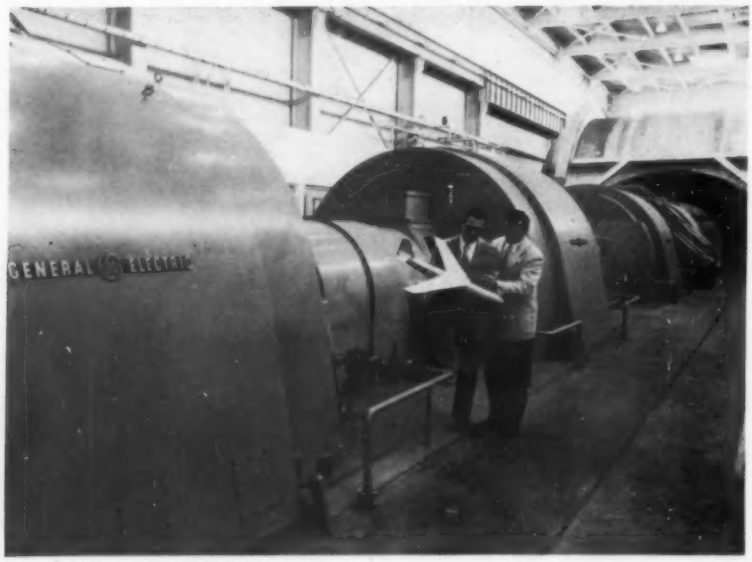
Newest feature of the show will be the atomic section, which is expected to produce striking disclosures among the widening applications of nuclear physics. One display will show a model of the first privately-financed critical facility and also an environmental test capsule, said to be the only one available which controls temperature accurately in reactor environment. There will also be research reactor models, a gas turbine for atomic plant use, and material relating to various operations in the application of atomic energy.

Electrical equipment will be strongly represented, not only in power units, such as a variety of motors and *continued on page 120*



Aerial view of New York's new Coliseum, at Columbus Circle and 59th Street

POWER ENGINEERING'S NEWS REEL

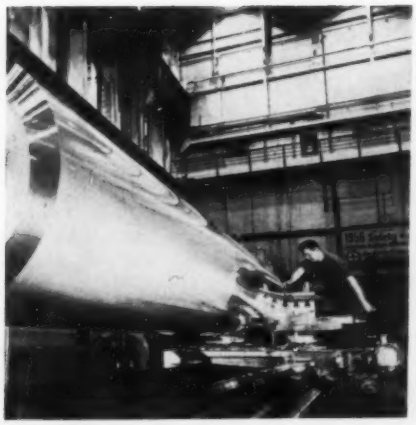


Most Powerful wind tunnel drive (*left*), is four-motor installation at Lewis Flight Propulsion Lab, Ohio. 250,000 hp gives Mach 3.5 wind speed

Tractor Boom broadens usefulness of LeTourneau machine; tractor pulls scraper, does other hauling jobs as well. Here, unit handles CI cylinders

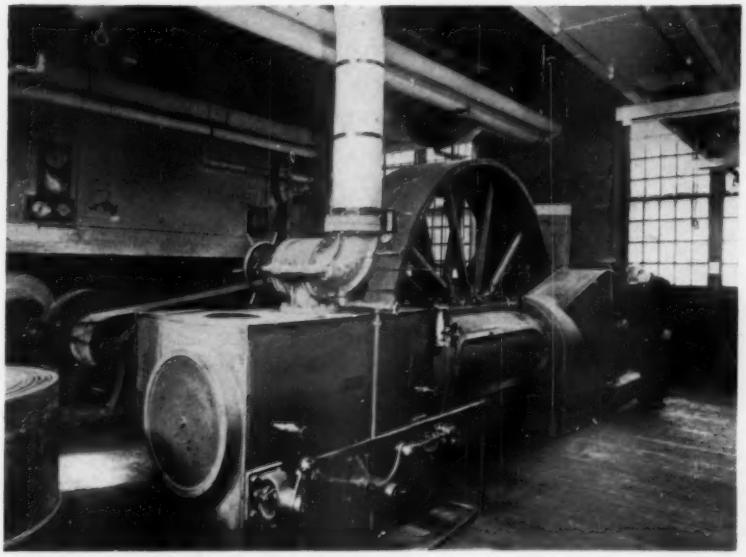
Award to Ford (*left, above*) is given by Society of Business Magazine Editors. First annual SBME Voice of Business Award was made to Henry Ford II for contributions to industry. *Left to right*: F. Tighe, *Motor Age*; Paul Wooton, SBME chairman; Mr. Ford; Eldridge Peterson, *Printers Ink*

More Atomic Power for Britain (*left*). Started in 1955, British Atomic Energy Authority's new nuclear power plant at Chapel Cross, Scotland, will generate 160 megawatts from four reactors. First unit to be ready in 1959, others, 1961



Still Working, old Corliss engine at the refurbished plant of Smithcraft Lighting Div. in Massachusetts does auxiliary duty whenever called upon

30-Ton Rotor (left) for Yorktown station of Virginia Electric and Power Co. is machined at Schenectady GE plant; unit will generate 150,000 kw. New station, adjacent to Amoco refinery, will use coke, by-product gases for part of fuel



Dam Painters use novel rolling rig to traverse dam face safely, easily. Stewart Mt. Dam, Arizona, is painted to reflect heat, lower dam temperature

Yumpin' Yiminey—it's a Yumbo! This truck-mounted hydraulic backhoe (*right*), called "Yumbo", has a wrist action at the end of the boom. Power comes from an International engine and oil pump. Controls are self-centering

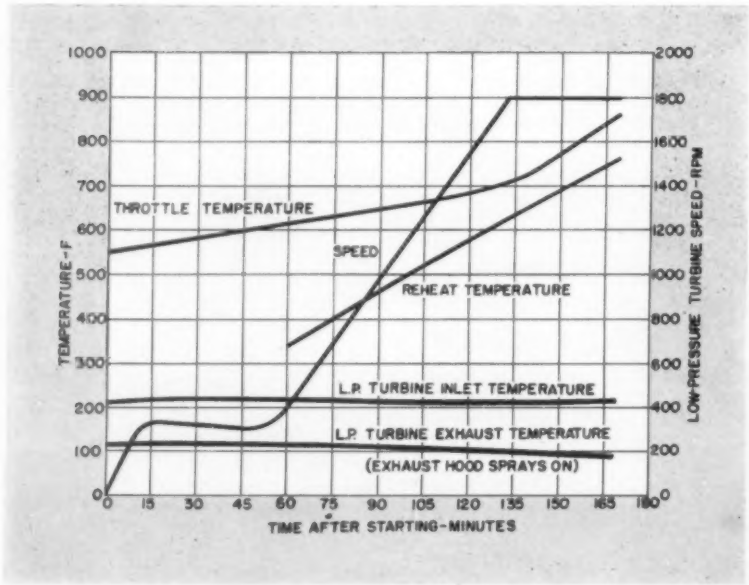


Chart shows typical temperature variation curves for the Ridgeland unit on start-up following a two-day shutdown

Thermal Stresses and Recent Turbine Failures

In Dec. '55 we published a report on causes of the Ridgeland turbine failure. Since then many readers have asked if thermal stresses contributed to failure. Answer is given here in H. D. Emmert's closure to the discussion of his paper on the Ridgeland turbine

IN HIS DISCUSSION of H. D. Emmert's* ASME Paper No. 55-A-172, F. E. Reed † suggested that in searching for some additional reasons which might help to explain the failure, it appeared that the failure might arise from the thermal stresses induced when warming up the turbine. He then went on to develop mathematical expressions for stresses that might occur as a result of spindle heating and cooling.

The following paragraphs are taken from the part of Mr. Emmert's closing remarks that dealt with Mr. Reed's suggestion:

Mr. Reed's thermal stress analysis closely parallels normal turbine design practice in general approach. The only significant differences are the designer's use of actual operating temperatures, experimentally determined film coefficients, and estimated isothermals for each specific spindle configuration.

Normal turbine operating procedure is of significance in considering the possible effects of thermal gradients and stresses in large shafts. In shutting down a large cross-compound machine, load is generally reduced gradually and the machine tripped off the line. Both shafts decelerate independently to a standstill and are then immediately placed on their turning gears.

At Ridgeland, the turning gears rotate the high-speed shafts at 40 rpm and the low-speed shafts at 20 rpm. For a two-day shutdown the shafts are kept rotating continuously, and after some hours the low-pressure shaft main body attains a fairly uniform temperature of about 175 F.

When the machine is to be started again, the stop valves and No. 1 inlet valve are opened and the shafts are rolled off the turning gear with steam. The chart shows a typical temperature variation curve for the Ridgeland unit on start-up following a two-day shutdown. These data are representative of the start-up on December 19, following which failure occurred.

As the shafts come off turning gear the throttle temperature is between 500 and 600 F, the low-pressure turbine inlet temperature is slightly over 200 F, and the low-pressure turbine exhaust temperature is slightly over 100 F. The temperature differential between steam entering the low-pressure turbine and the adjacent spindle surface metal is less than 50 F. Thermal gradients within the spindle are much smaller.

Turbine speed is brought up rapidly to about 325 rpm on the low-pressure shaft and held for 30 to 40 minutes. During this time vacuum is improved and throttle temperature is increased about 50 F. The turbine is then accelerated uniformly to rated speed over a time interval of approximately one and one-half hours.

This chart shows throttle and reheat temperatures are gradually increased during this period, but low-pressure turbine inlet temperature remains essentially constant. Cylinder and spindle metal temperatures in the vicinity of the low-pressure turbine inlet gradually approach 200 F during this period.

If the turbine is to be oversped after attaining rated speed, the inlet valve is opened further to accelerate the machine and the low-pressure turbine inlet temperature tends to rise. This rise is not great and is for only a brief period. As soon as the machine trips out, the temperature drops back down to the 200 F level. The change in spindle metal temperature during this short interval is insignificant.

Our reasons for considering that thermal stresses did not play a dominant part in the Ridgeland low-pressure turbine failure will be evident from the above data. Analyses of thermal effects are an important phase of modern turbine engineering, and the results on any specific machine not only dictate much of the design, but they also establish recommended operating procedures and schedules such as shown in the chart. That the thermal-stress level permitted by such operation is not dangerous in the absence of abnormal discontinuities or stress raisers is well evidenced by the successful long-time operation of many machines under similar and frequently more strenuous conditions. The basic test for any theory of failure is whether it satisfactorily separates the unsuccessful from the successful. The assumption that thermal stresses were a primary cause of the Ridgeland failure does not meet this test.

* Assistant Chief Engineer, Steam Turbine Department of Allis-Chalmers Mfg. Co.

† Technical Operations Inc., Arlington, Mass.

Fig. 1. Lime waste treatment plant of Eastman Gelatin Corp.

Fig. 2. Primary settling tank, 90-ft dia, receives effluent

Editor's Note: POWER ENGINEERING is pleased to be able to present to its readers this unusual work on a problem which, so far as we know, has not previously received attention in the technical press. There appears to be no existing literature on either the flue-gas method of precipitating heavy lime wastes or on the closely-related problem of scrubbing flue gas with soda ash to remove both fly ash and corrosive sulfur compounds simultaneously.

The methods by which these problems were solved have been developed at considerable expenditure of time and money, but the Eastman Gelatine Corp. regards publication of these data to be in the nature of a public service; it is their hope that others with similar problems may profit by their experience.

For those interested in the nature of the studies that led to the successful application of this lime treatment system, there is included a special section that describes details of the pilot plant experiments that preceded construction of the full-scale facilities at the company's Peabody plant.

Flue Gas Solves Lime Waste Treatment Problems

By M. D. GIVEN*

DISPOSAL OF large quantities of heavy lime wastes has always posed serious problems to the gelatin and glue and tanning industries. Where such waste liquids are discharged to closed sewer mains, encrustations build up in pipes with consequent reductions in their load-carrying capacities. The encrusted material is extremely difficult to remove, and when lines are loaded to capacity, results are easily imagined. If wastes are discharged to open rivers or streams, pollution is likely to result. In either case, authorities, local or otherwise, are apt to insist on some sort of treatment of the wastes prior to their discharge.

The serious aspects of this problem were recognized as early as 1923 by Eastman Gelatine Corp. (then American Glue Co.); at that time, a large primary settling basin was built to remove most suspended solids from the wastes. Operation of this basin did improve considerably the quality of our waste outfall, but it was soon evident that this was only a partial solution of the problem.

In 1929, it was suggested to us by the South Essex Sewage District laboratory that running flue gas from our power house stack into the effluents from our primary settler might precipitate most of the remaining lime in the form of calcium carbonate. Laboratory experiments indicated that the process was chemically sound, and in 1931 we built our first large-scale plant for carbonating lime wastes. It consisted principally of a rectangular concrete basin 100 ft by 50 ft by 12 to 15 ft deep (bottom sloped longitudinally). Flue gas was distributed to the liquid in this basin by a gridwork of piping ending in several hundred 1-in. by 9-in. cones pointing downward, at a depth of approximately seven feet. Flue gas was taken directly from our power house stack and pumped by a 960-cfm positive pressure blower through a 12-in. steel pipe to the basin header.

Necessity for removing fly ash and corrosives from the flue gas was not recognized at this time so no means for their removal were provided. Furthermore, no way for continuous removal of accumulated carbonate slurry was provided and consequently the basin had to be shut down periodically while accumulated sludges were removed with a bucket crane.

By present standards, this equipment was crude, but for all its defects it did remove a considerable percentage of the lime from our sewage outfall. It was kept in operation intermittently from 1931 to 1946; pressure from local authorities increased as loads in sewer mains increased and it was recognized by the Company that there was a real need to prevent the plugging of sewer mains with lime encrustations. It was then decided, if it were shown to be practicable, to build a completely new lime removal plant, which it was hoped would completely remove all lime from our wastes prior to their discharge to city mains.

Cost of the proposed plant was, of course, a consideration since it was likely to be large. Also, little or no data in the literature existed due to the novelty of this process. We had accumulated rather complete data on the primary settling of the wastes, but many of the variables involved in carbonating and final settling remained unresolved or obscure. With these things in mind, we felt that it would be wise to build and operate a pilot plant before pro-

*Chief Chemist, Eastman Gelatine Corp.

ceeding to full-scale building. The pilot plant was completed in February, 1946, and from that time until April, 1946, we investigated all known variables in the process. A description of equipment used and operations followed in the pilot plant are described in the accompanying special section.

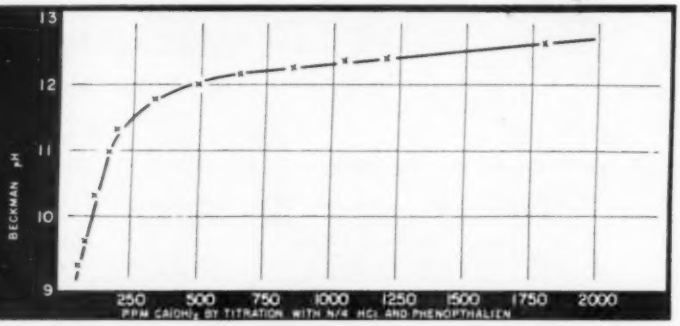
As a result of our pilot plant study of each of the known process variables, sufficient data was obtained to calculate required sizes and capacities of full-scale basins and other equipment. The flow diagram in Fig. 6 indicates each important piece of equipment and its function.

Primary Settling Basin: This is a circular concrete basin 90 ft in diameter with an 11-ft average depth (Fig. 2). A slowly moving rake near the bottom moves accumulated slurry to the center, whence it is removed by intermittent pumping. Capacity is 525,000 U. S. gal; retention time is 12.6 hr at an average flow of 694 gpm.

Carbonating Basin: This concrete basin is rectangular, 40 by 100 ft, and has an average depth of 10 ft (Fig. 3). It is divided longitudinally by a wall into two sections each approximately 20-ft wide. A chain scraper conveys accumulations of slurry continuously to a sump at the low end. The sump is pumped out intermittently. Capacity of double basin is 300,000 U. S. gal., and retention time is 7.2 hr at average flow of 694 gpm.

Flue gas is introduced into the basin by a 12-in. steel header pipe to a gridwork of pipes ending in

Pilot Plant Operation Proves Flue Gas Can Treat Lime Waste



BEFORE BEGINNING the construction of facilities to purify the heavy lime wastes from their manufacturing operations, Eastman Gelatine Corp., Peabody, Mass., built a pilot plant to obtain data on the unique treatment process that was contemplated. Following is a description of the equipment and methods used in the operation of the pilot plant, together with a summation of the results that enabled full-scale facilities to be constructed without trial-and-error procedures.

Equipment and Operations

Our pilot plant consisted principally of two 2000-gal. cylindrical wooden tanks 6 ft in dia by 10 ft deep, so arranged that metered flue gas could be introduced into one tank by means of a gridwork of pipes and cones. Measured quantities of waste liquids (effluent from the existing primary settler) were pumped to this carbonating tank where they were processed and then run by gravity to the second tank for sedimentation.

By means of this equipment and through use of meters at appropriate places, we obtained fairly complete data on the following variables:

1. Quantities of waste liquids to be treated
2. Concentrations of lime in liquids
3. Quantity of flue gas required
4. Size of equipment necessary for full-scale operations
5. Gas absorbing efficiency of the apparatus
6. pH control (to prevent over-carbonation and re-solution)
7. Quantities and nature of slurries formed

Quantities of Waste Liquids to be Treated

Using flow meters and other suitable devices, we measured the quantities of wastes contributed by each of several departments. The data was collected over a considerable length of time to allow for hourly, daily or seasonal fluctuations in flow. A summary of the data follows:

Period	7 A.M. to 3 P.M.	3 P.M. to 11 P.M.	11 P.M. to 7 A.M.
Quantity	470,850 gal.	274,100 gal.	274,100 gal.
Flow Rate	981 gpm.	571 gpm.	571 gpm.

It will be noted that there was a considerable range of quantities and flow rates for the three eight-hour periods into which we divided the day.

Stated briefly, it appeared that after primary settling we should have approximately 1 mgd of waste-liquid with distribution of flow as shown above.

Lime Concentrations

Pilot plant data, plus figures accumulated through several years of operating our first large-scale lime removal plant, indicated that our waste liquids, *after primary settling*, would assay: 500 to 3000 ppm $Ca(OH)_2$, with an average of 1800 ppm.

Since lime is soluble in water from 1850 ppm at 0 C to 1570 ppm at 25 C, it might be expected that efficient primary settling would give effluents approximating these figures at similar temperatures. Due to the gelatin process, however, there are appreciable amounts of hair extract, mucins, lime soaps, and other organic materials present in our waste liquids. As a result, some of the particles of lime remain suspended in the wastes even with efficient settling apparatus and with retention times up to 12 hours. A 500,000 gal. basin is a sizeable piece of equipment, and our experiments led us to doubt whether increasing the size and retention time further would give effluents sufficiently better to justify the large increase in cost. We decided, therefore, to proceed on the basis of a 500,000-gal. primary basin yielding effluents about as indicated in the preceding paragraph.

Flue-Gas Required

Many trial runs were made in the pilot equipment — batchwise at first, and later, on a continuous flow basis. All variables were carefully checked during these operations until we felt satisfied that we had the answers to all phases of the carbonating and final settling operations. Turbulence, for example, must be sufficient for thorough mixing of gas and liquid but must also be held in bounds to prevent splashing over. The liquids were found liable to foam badly at pH levels above 9.0, but when controlled at pH 7.0 to 8.5, tendency to foam formation is slight. During the experimental runs, liquid levels were maintained one foot below the top rim of the carbonating tank. Finally, we arrived at a flow rate which satisfied all conditions of mixing, turbulence, splashing, and tendency towards foaming and, at the same time, maintained pH and alkalinity at proper levels. A summary of all data and measurements made at this optimum flow rate follows:

Cylindrical wood tank 9 ft 5 in. high by 6 ft dia., inside dimensions
Liquid outlet: 1 ft below top rim of tank
Gas cones: Four cones provided for 28.27 sq ft of liquid surface, or, one cone for each 7.07 sq ft of liquid surface. Bottom of cones 5 ft 7 in. below liquid level
Useful volume of tank: 1700 U. S. gal.
Optimum liquid flow: 4.6 gpm. of wastes containing 2000 ppm lime
Flue gas (12 per cent CO_2); 2.75 psig and 70F: 400 cu ft/hr required to maintain pH 8.3, or zero alkalinity, at optimum liquid flow

Before converting this pilot data for gas required to full scale requirements, let us first list the expected quantities,

cones about 7 ft below liquid level.

Final Settling Basin: Similar in construction to the primary basin, this unit is 60 ft in diameter with an average depth of 11 ft.

Capacity is 233,000 gal.; retention time is 5.6 hr at average flow of 694 gpm.

pH Control Equipment: Sampling line takes waste liquid from each side of the carbonating basin to a small box in a nearby building. The box is baffled and a small stream of compressed air mixes the two sample streams thoroughly before the liquid is passed to a set of flow-type pH electrodes. pH measurements are transmitted through an amplifier to a controller which in turn actuates an air-operated valve that releases flue gas to atmosphere when not required. With this arrangement, it is possible to control pH of the effluent from the carbonating basin to within plus or minus 0.5 pH units of a predetermined set point.

Flue Gas Pumping Equipment: Two 1000-cfm positive pressure blowers were originally provided for moving flue gas through the system. After several years of operation, however, maintenance, repairs, and replacement costs were so high that the blowers were replaced with a steam ejector of similar capacity (Fig. 4). The ejector is rated at:

2460 cfm. at 27.7 in. Hg abs, and 125 F
Suction pressure 27.7 in. Hg abs.
" temperature 125 F
Discharge pressure 5 psig
Steam " 225 psig, 575 F

The ejector has now been in con-

Fig. 3. Concrete carbonation tank where flue gases are introduced into effluent by cones about 7 ft beneath top surface. Lime in the effluent is precipitated in the form of calcium carbonate; a chain scraper moves deposited sludge to sump

flow rates and concentrations of lime for our waste liquids:

Average Liquid Flow: 1 mgd, or 694 gpm
Maximum Liquid Flow: 981 gpm
Maximum lime concentration: 3000 ppm $Ca(OH)_2$
Pilot temperature and pressure of flue gas: 70 F, 2.75 psig

We found that a liquid flow of 4.6 gpm containing 2000 ppm $Ca(OH)_2$ required 400 cu ft/hr of 12 per cent flue gas to maintain zero alkalinity. If we project this data to full-scale requirements using maximum flow rate and concentration, we find:

$$\frac{400 \times 981 \times 3000}{4.6 \times 2000 \times 60} = 2132.6 \text{ cfm 12 per cent } CO_2 \text{ flue gas at 70 F and 2.75 psig are required.}$$

Temperatures and pressures of the flue gas in the full-scale equipment differed somewhat from those used in the pilot experiments but not enough to cause concern over the accuracy of our estimate. However, considerations of equipment size and cost, as well as some doubts about ranges of flow and concentration of lime, finally led us to compromise on 2000 cfm of flue gas, conditions of temperature and pressure as above, as probably sufficient for the job.

Basin Sizes for Full-Scale Operation

Carbonating Basin. Projecting the previous data to full-scale by proportion, we find that the proper capacity of the carbonating basin should be:

$$\frac{1700 \times 694}{4.6} = 256{,}700 \text{ gal. for average flow of 694 gpm, or,}$$

$$\frac{1700 \times 981}{4.6} = 362{,}540 \text{ gal. for maximum flow of 981 gpm}$$

Again, considerations of size and cost of equipment, as well as probable maximum ranges of flow and lime concentration, led us to compromise on a tank:

Dimensions: 40 ft by 100 ft by 10-ft average depth
Capacity: 40,000 cu ft, or 300,000 U. S. gal.
Retention time: approximately 7.2 hours.

Final Settling Basin. Time did not permit our carrying pilot experiments to a complete conclusion for suspended solids in the effluents. We did, however, have data which indicated that, operating at 4.6 gpm, and with tanks used in our pilot experiments, approximately 90 per cent of the solids carried over from the carbonating tank would settle out in the final tank in four hours. This applied to liquids initially containing only 2000 ppm of lime and the effects of increasing initial concentrations to 3000 ppm was not known. A tank for 1 mgd with four hours retention time would require a capacity of 167,000 U. S. gal., but because of the uncertainties mentioned above we decided upon a tank having dimensions and capacity as follows:

Dimensions: Circular, 60 ft dia by 11-ft average depth
Capacity: 31,097 cu ft, or 233,228 U. S. gal.
Retention time: approximately 5.6 hours.

Gas-Absorbing Efficiency

Flue gas was introduced into our first crude carbonating basins by means of cones suspended on iron pipes at a depth of about seven feet. Several years of usage taught us that this method, while perhaps not beautiful, did a good job of gas distribution and had few defects. We were never bothered by clogging of the cones, although occasionally a few of them broke loose and dropped to the bottom of the basin.

Other methods were considered, such as passing gas through ceramic plates to break up the gas flow into very small bubbles prior to mixing with the liquid. This could possibly improve the absorption of gas by the liquid but has never been tried here because we feared that the small pores through which the gas must pass would easily become clogged with solids. We finally decided to proceed using the pipe and cone distributing system; we are still using it today.

After the pilot experiments, we had sufficient data to calculate the efficiency of our system in absorbing CO_2 from the flue gas supplied to it. The basic reaction for the process may be written thus:

$$\underset{7.57}{Ca(OH)_2} + \underset{x}{CO_2} = \underset{74.09}{CaCO_3} + \underset{44}{H_2O}$$

Solving: x = 4.5 grams CO_2 theoretically necessary to neutralize 1 gal. lime waste containing 2000 ppm, or 7.57 grams $Ca(OH)_2$. Our pilot experiments showed: 2000/1700, or 1.17 cu ft of 12 per cent flue gas at 70 F and 2.75 psig (equivalent to 8.94 grams CO_2) actually required to neutralize 1 gal. of waste containing 7.57 grams $Ca(OH)_2$.

Therefore, the weight of CO_2 theoretically required to neutralize a unit weight of lime, divided by the weight of CO_2 actually required by our apparatus, equals the efficiency of the apparatus in absorbing CO_2 from the gas, thus: 4.5/8.94 = 50.3 per cent efficiency.

pH Control

During the course of our pilot experiments, we investigated the relationship between pH and alkalinity of the waste liquids while carbonation was in progress. A portable pH meter with glass electrode was used for pH measurements,

tinuous service for over a year. To date no repairs have been required and the ejector is still delivering it's rated capacity. The ejector has proven definitely superior to positive pressure blowers for this application. It is only fair, however, to point out that had we originally placed the blowers more advantageously, a different conclusion might well have been reached.

Flue Gas Scrubbing Equipment: Flue gas was at first drawn from our power house stack and passed directly through the blowers to obtain the pressure necessary for the application. Necessity for removing fly ash and corrosives was not immediately recognized. Very soon, however, corrosion-erosion showed up in the form of a hole eaten through a 12-in. mild steel elbow at a point where condensates from the gas could collect in some quantity. In addition, examination of moving parts of the blowers revealed that they too were being worn and corroded by fly ash and sulfur compounds in condensates. To avoid excessively high repair and replacement costs it was imperative that something be done quickly. We had little success with a search of the literature, but eventually Chemical Construction Co., aided by Pease, Anthony Equipment Co. and our engineering staff, designed and built a scrubber which we hoped would remove fly ash and corrosives sufficiently to permit flow of gas but with damage to pipe-lines, blowers, etc., reduced to a reasonable minimum. Principal parts of the scrubber, e.g., venturis and cyclone-separator, were fabricated for us by

Fig. 4. Steam ejector which replaced original installation of two 1000-cfm positive pressure blowers does good job

and alkalinity was determined by titration of suitable samples with standard acid using phenolphthalein indicator. Results of one such experiment are shown in the graph.

This graph shows how the relationship looks as carbonation proceeds from 2000 ppm $Ca(OH)_2$ downward to zero alkalinity. As expected, zero alkalinity was found to occur at approximately pH 8.3. At pH 9.5, alkalinity has been reduced to 75 ppm $Ca(OH)_2$, the maximum permitted by our present sewage laws. Slope of the curve suggested that it should be possible to devise some means for control of carbonation by controlling pH in the carbonating basin.

Neutral calcium carbonate is soluble only to the extent of about 14 ppm at pH 8.3, but 200 or more ppm are soluble at lower pH levels. Operating without pH control would therefore make re-solution of part of the neutral carbonate a certainty at times when more gas than necessary was supplied to the basin. This would permit considerable lime in the form of bicarbonate to pass to the sewers. A rise in pH downstream, either through loss of CO_2 from the wastes, or by addition of more alkali, would result in more neutral carbonate precipitating out on the pipe, and of course this is the very thing we are trying to prevent.

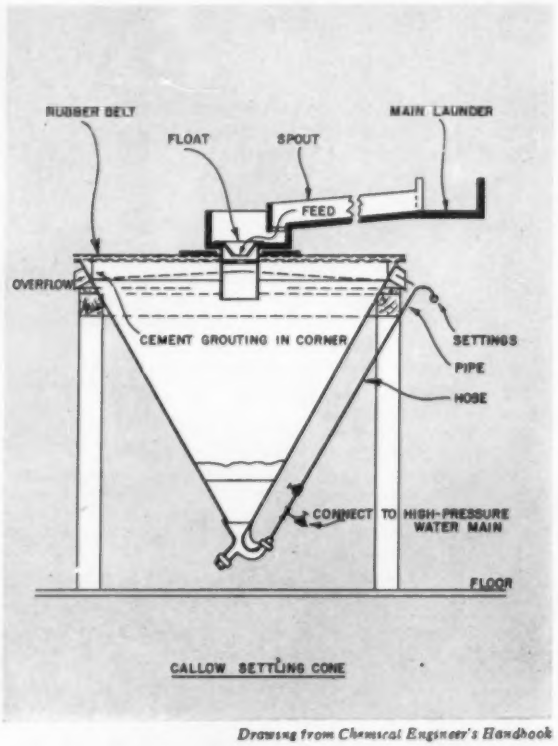
Our solution to this problem was installation of a good recorder-controller and flow-type pH electrodes, with amplifier, connected to sampling lines from the carbonating basin. A portable pH meter and hand operation of gas control valves was used to advantage to locate optimum points for sampling. The controller was connected to an air-operated valve so that any excess of flue-gas over actual requirements would be exhausted to atmosphere. The system worked out well, giving control to about plus or minus 0.5 pH units at a selected control point.

As an extra dividend, by blowing excess gas to atmosphere, our attention was called to the fact that there were long periods when less than full flow of flue gas were required. By careful scheduling of gas flow during night hours and over weekends, we were able to maintain a sufficient flow of gas for operating, and also obtain a worthwhile saving in power.

Nature of Slurries

Lime Slurry. Well established data obtained through operation of our first primary settling basin showed that we might expect slurry from this source averaging about as follows:

110 tons/24 hours slurry: density 10 lb/gal., 13.1 per cent dry solids
or: 22,000 gals slurry/24 hours
or: 14.3 tons/24 hours of dry solids.



Drawing from Chemical Engineer's Handbook

Fig. 5. Drawing of a typical Callow cone shows how scrubber return enters at top center; liquid returns to constant-level make-up box, flue-dust slurry is siphoned out bottom to sewer

Carbonate Slurry. In our pilot experiments we noted that some carbonate settled in the carbonating tank in spite of the considerable turbulence, while the balance passed on to the final settling tank. No determination of distribution between the two was made but we did note, that of the solids passed on to the final tank and at reasonable flow rates, some 90 per cent settled out in four hours. Time did not permit a complete investigation of the nature and quantity of slurry resulting from the precipitation but we did make an estimate based on data available at the time. We have shown expected quantity and lime concentration of waste liquid to average 1 mgd and 1800 ppm $Ca(OH)_2$. Using these figures and assuming a density of 1.0 for the precipitated carbonate, we should expect to have 15,021 lb $Ca(OH)_2$/24 hr, or 20,290 lb $CaCO_3$/24 hr. This data is summarized as follows: Estimated (approximately): 10 tons carbonate per 24 hours, dry basis; or, 100 tons slurry per 24 hours, 10 per cent solids basis. Assuming a density of 10 lb/gal. for slurry, we have approximately 20,000 gal. of slurry containing 10 per cent solids every 24 hours.

Our estimates for both lime and carbonate slurries checked out well with quantities actually obtained later from full-scale plant operations. (*End*)

Chemico; other components like the Callow cone, makeup fan, liquid pumps and other auxiliary equipment were purchased from best available sources. Scrubber is shown in Figs. 7 and 8.

Ejector is placed downstream from the scrubber which is therefore under a vacuum of about 30 in. of water. In operation, gas flows from the power house stack through mild steel pipe, through the two venturis, to the cyclone, then out the top to the clean gas line. The scrubbing liquid used is a dilute solution of soda-ash; water would scrub out fly ash or other solids but alkali is necessary to neutralize sulfuric acid and other corrosive sulfur compounds present in the gases. Scrubbing is accomplished in two steps: first, in the venturis by injecting scrubbing liquid at right angles to the gas-flow, and second, in the cyclone where the gas again contacts scrubbing liquid in the form of a fine mist from high pressure spray nozzles. The bulk of fly ash and corrosives is removed in the first scrubbing operation while most of the balance is removed in the second stage. Entrained liquid is spun out centrifugally in the separator and returned, via a Callow cone for solids removal, to the system for recirculation. Before recirculation, water lost by evaporation and underflow is made up by a float-valve and box arrangement, and fresh soda-ash is added to maintain the pH of the scrubbing liquid at 7.0 to 8.0. A rotameter controls additions of soda-ash conveniently.

With all parts of the equipment in good working order, and at gas flows within the capacity of the scrubber, we have been able to remove 90 per cent or better of solids and 95 per cent or better of corrosives from the flue gas. To neutralize remnants of SO_2, etc., from the clean gas, we bleed into it a small amount of gaseous ammonia, again using a rotameter for control. We have found it possible in this way to control pipe-line condensates to approximately pH 7.0, at which point they have little ability to corrode metals.

I wish that I could report here that all of our corrosion troubles stopped after the scrubber was installed. Such is not the case, however, for we have had a pipe-line failure from corrosion very recently. Neither do I mean to infer that the scrubber has been a failure. In principle, we believe the apparatus to be sound, although a few details remain to be solved before we can state unequivocally that it is a complete success.

There are three major problems remaining, two of which could be solved by equipment or procedural changes, while the third may prove more difficult.

Capacity of Scrubber: Through an oversight in the original calculations the scrubber was originally built to handle about 2000 cfm of flue gas, saturated at 115 F, a quantity that was less than actually required. With some minor changes in the equipment the scrubber was later able to handle the 3000 to 3500 cfm required. It is, however, a borderline operation, with the scrubber handling this quantity efficiently only when all auxiliary equipment is in perfect condition. There is no marginal capacity for wear in circulating pumps, clogged spray nozzles, etc.; hence, when such things occur, we are forced to operate the scrubber below maximum efficiency. The obvious remedy is to replace the present scrubber with another which would have suitable overcapacity and this will probably be done at some future time.

Clogging of Spray Nozzles: We have had, at times, some trouble with clogging of the nozzles, but we believe this has been largely eliminated by a regular weekly cleaning schedule. As stated, since our scrub-

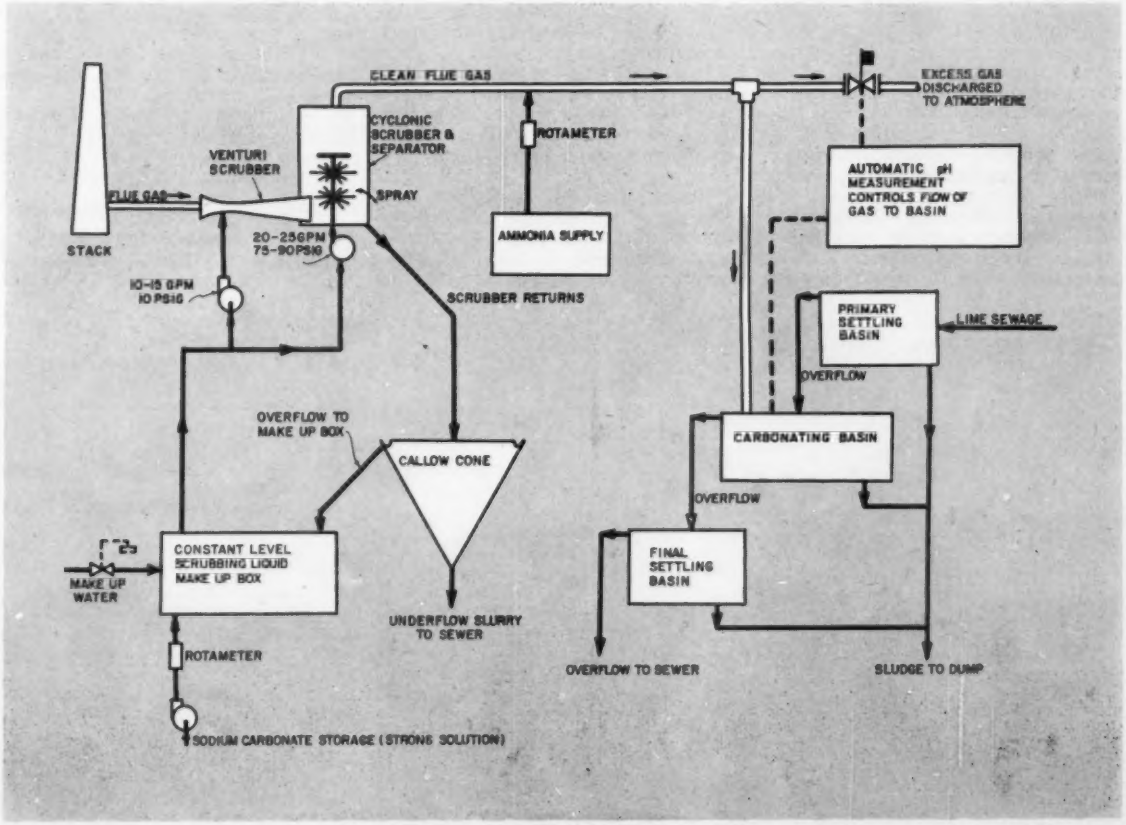


Fig. 6. Flow diagram of sewage purification system at Eastman's Peabody plant shows components of system now in use

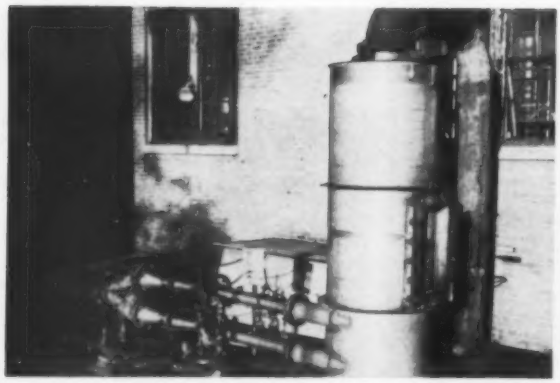


Fig. 7 Flue-dust scrubber showing venturi section, cyclone

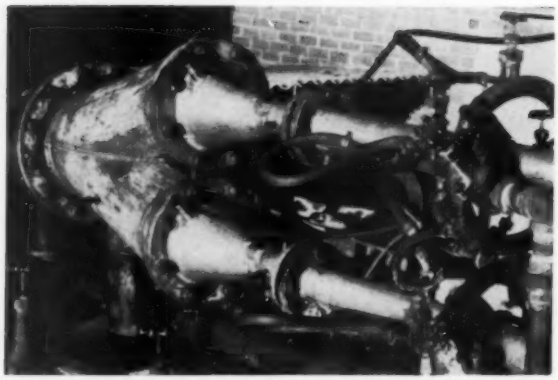


Fig. 8. Enlarged view of the venturi section to show piping

ber is of borderline capacity, clogging of even a few of them severely reduces overall scrubbing efficiency. We do not believe this would be much of a problem with a properly oversized scrubber.

Failure of Circulating Pump: This high-pressure pump circulates about 20 gpm of hot, dilute soda-ash solution at 75 to 90 psig through the spray nozzles of the cyclone. Temperature of the liquid circulated by the pump is about 125 F, pH about 9.0, and it contains considerable amounts of suspended carbon and fly ash. This combination has particularly severe corrosion-erosion properties and keeping pumps in this service has caused us trouble from the beginning. Small turbine-type pumps originally supplied with the equipment lasted about one week. Open impeller, cast-iron centrifugal pumps did somewhat better, lasting perhaps three months at most. We are now experimenting with hardened and alloyed materials hoping for still further improvement. Experimentation seems to be our only recourse, as pump manufacturers are unwilling to recommend a complete solution of the problem. This will take time but we believe we shall eventually arrive at a solution.

There has been an understandable tendency on the part of operators to stretch out the life of the pumps as far as possible. Scrubber efficiency drops rapidly, of course, as flow of liquid to the nozzles diminishes. Solution of this problem should therefore go a long way toward keeping our scrubbing equipment running at top efficiency. Finally, it is our belief that present failures of downstream pipe represent compromises made in the past with more frequent changes of these pumps.

In summing up the performance of our scrubbing equipment, we believe that when the three problems just discussed are solved, we shall have a completely satisfactory system.

Slurry Disposal: Both lime and carbonate slurries are disposed of by trucking to a large waste land area and there dumped. Haulage distance is about one mile round trip, and one tank-truck and driver are required for five full eight-hour days per week (Fig. 9).

Possibility of dewatering the slurries has been explored because, if it were feasible, both haulage costs and the dump area necessary would be reduced. However, our findings indicate that the best that could be expected of a good vacuum filter would be to reduce a slurry of 10 per cent solids to a wet cake of perhaps 40 per cent solids. While this would reduce haulage weight about 75 per cent, cost of building and equipment, depreciation, and operating costs for the equipment would more than offset the possible gain.

We have concluded that unless a ready market for the wet cake can be found, dewatering slurries would be unprofitable. Of course, if a large dump area was not available to us nearby, the economics of the situation might dictate differently.

Over-all Performance

We do, naturally, have occasional shutdowns of equipment because of repairs to flue gas pipe lines, maintenance of pumps, and work of similar nature. For the most part, however, we have run continuously since installation of the system, and performance in terms of lime removal has been excellent. Effluents discharged to our sewer mains are usually well within limits set by local statute for both alkalinity and suspended solids.

By contrast with our earlier operations, our present lime removal operations look very good indeed. Some minor equipment changes are needed, but when these are made, substantial improvements in reducing maintenance costs and in increasing quality of effluents should result.

Problems connected with gas scrubbing are pretty well understood here and we feel that their complete solution is only a matter of time. When this has been accomplished, we hope our waste disposal plant will serve as a model for others who may have difficulties in this kind of operation.

Fig. 9. Sludge storage tanks and tank truck used to haul sludge to nearby dump

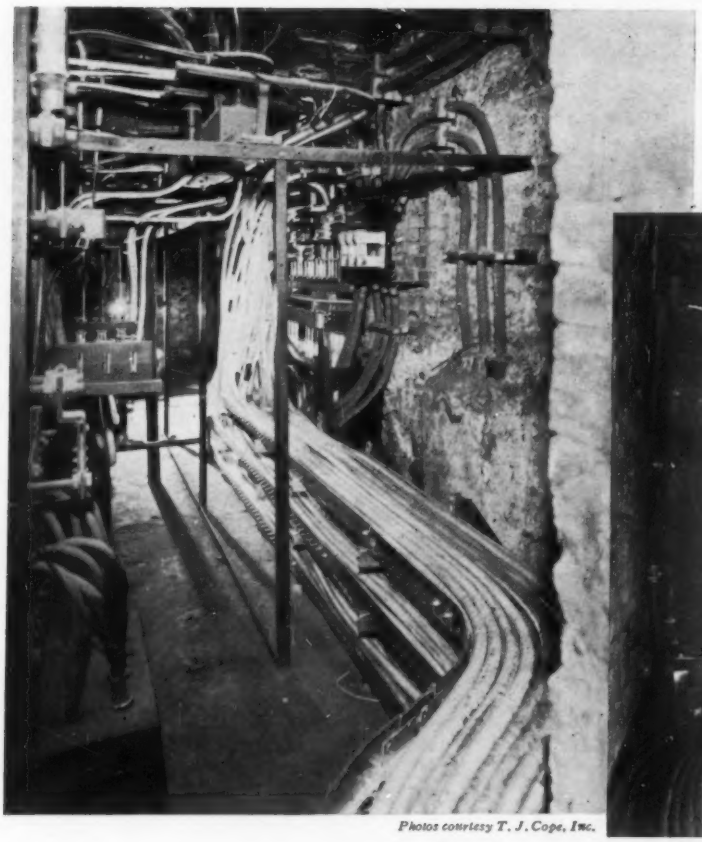
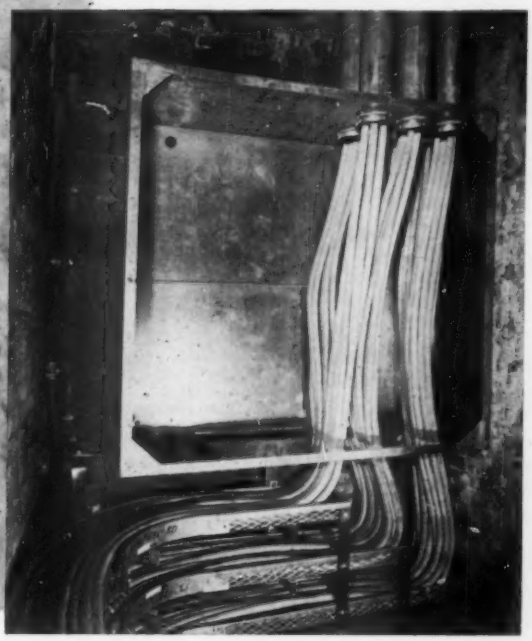


Fig. 1. Left: Shows crowded state of old wiring and difficulty of adding new

Fig. 2. Below: Combination of conduit and trough makes neat job where space is scarce



Photos courtesy T. J. Cope, Inc.

Gimbels Revamps a Half-Century of Wiring

Competing claims for cable trough and conduit often suggest that one or the other can solve all wiring problems. But for recabling like this, combination of the two often gives best results

By RUSSELL R. TULL *

LIKE THE OWNERS of many older buildings, the Market Street store of Gimbels in Philadelphia has recently been faced with the problem of installing new cables to meet modern load requirements. The lighting system, for example, originally was installed to handle the old arc lights prevalent at the turn of the century. Since existing cables couldn't begin to do the job required by modern lighting, entirely new control and power circuits had to be run to replace the existing system. Naturally, there could be no interruption in service.

Our company was employed to install the new wiring and although the present distribution system is only a step toward the eventual complete rehabilitation of the distribution system, we ran into a number of interesting problems that may be of help to others planning to remodel existing buildings to meet modern loads.

The primary flow is from a 15,000-v #2 cable. This feeds into a transformer and from the transformer a 220-v supply is carried through bus duct to distributing circuit breakers. These circuit breakers are located on the floor above the street level and from them the cable is carried through the floor in aluminum conduit, outside the building, and then dropped through the street itself into the basement. Aluminum was used for the cable supporting system because the existing structure would not support the added weight of steel.

In the basement each of the six 5-in. aluminum conduit carries 8 cables to feed the lighting system for the east building. The basement of the east building is extremely crowded, as can be seen in Fig. 1, and, at the time work began, was filled with antiquated wiring. It would have been a very difficult matter to have continued the conduit system through this crowded area and we found that much the simplest and least costly solution was the use of expanded metal cable trough.

The 6 conduits are fed into a box and secured to it to provide a continuous metallic system. The box itself is grounded. From the box the cables are fed directly into 3 rows of 12 in. wide trough. The trough supports are welded to the box to continue the metallic contact.

Actual run of the trough is not long — 100 ft or so. From the end of the trough the cables are fed directly to the main bus structure and are so fed into the main board.

It would have been difficult to complete this system with either conduit or trough alone. But a proper combination enabled the job to be done quickly and economically.

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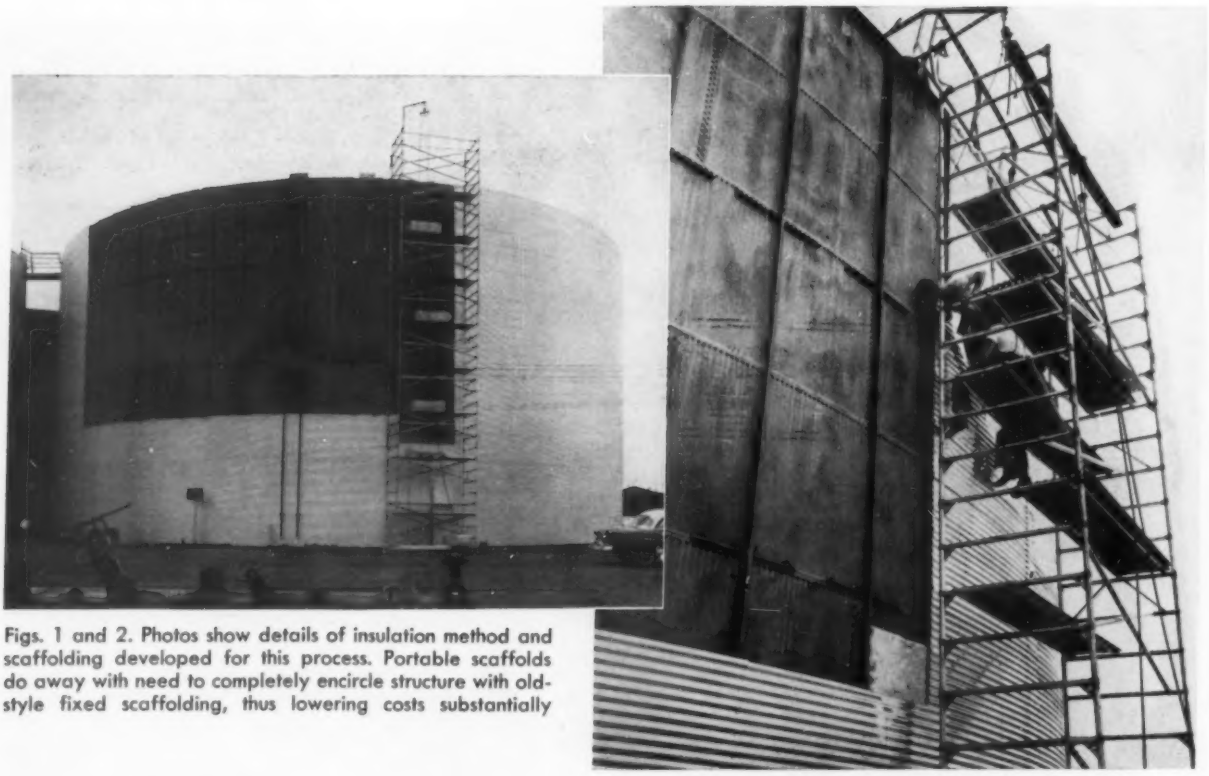
*Vice-President, The Chas. E. Tull Co. Inc. Electrical Constructors.



Figs. 1 and 2. Photos show details of insulation method and scaffolding developed for this process. Portable scaffolds do away with need to completely encircle structure with old-style fixed scaffolding, thus lowering costs substantially

Here's Way to Lick Your Temperature Problems in Liquid Storage

Maintaining the temperature of stored liquids is frequently a problem, and thus tank insulation is required. Often, however, cost of application plus maintenance and short life prevent realization of actual savings. Insulation method shown here is effective, reasonable in first cost, long-lived, and upkeep of aluminum sheathing negligible

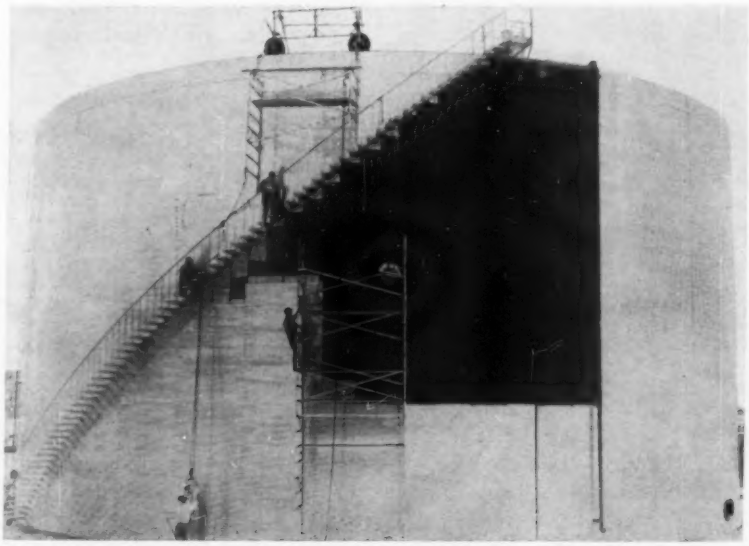


Fig. 3. Vertical steel supporting members are tack-welded to tank; where welding cannot be used, special stainless-steel bands serve purpose. Sheathing secures to supports with special fittings. (Note how the special scaffolding adapts to job)

For more information, write the Editor, POWER ENGINEERING, 110 S. Dearborn St., Chicago 3, Ill., or jot down "Tank Insulation" on return post card in this issue.

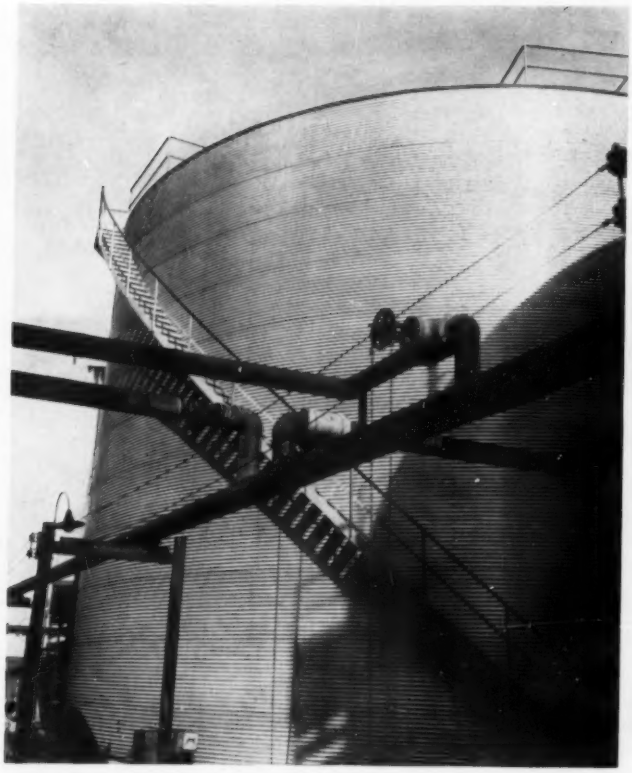


Fig. 4. (*Left*) Completed insulation job on one of five tanks at a large mid-West refinery. Insulation may be Foamglass, Fiberglas, Styrofoam, Kaylo, mineral wool felt, many others

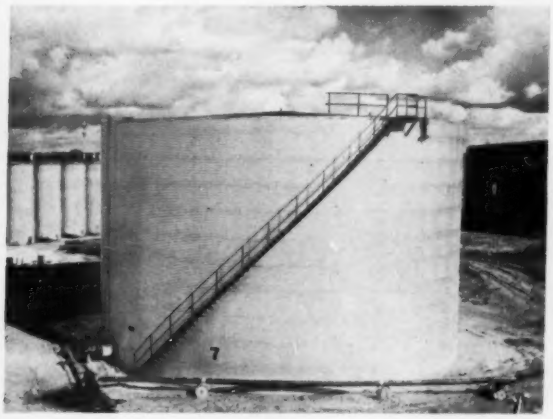


Fig. 5. (*Above*) Asphalt tank at Michigan refinery. Job was completed in 1954, but aluminum sheathing looks brand new

Fig. 6. (*Right*) Two of 37 tar tanks for a national tar products company. Long-lasting sheet-metal sheathing protects insulation from weathering yet permits structure to "breathe" and thus controls effects of condensation

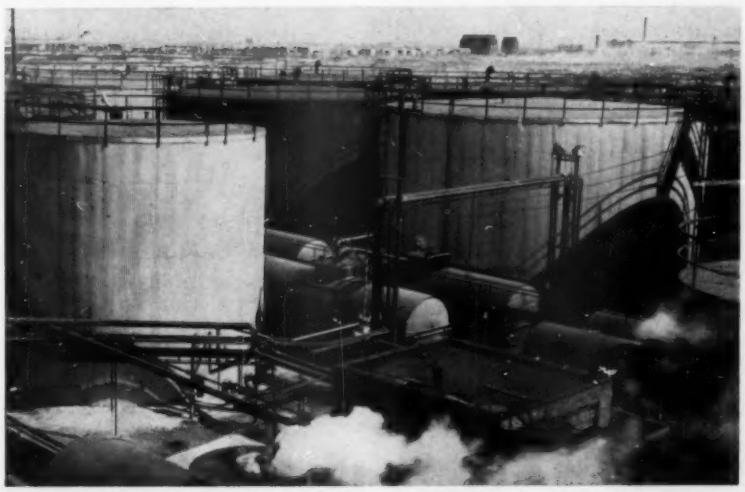
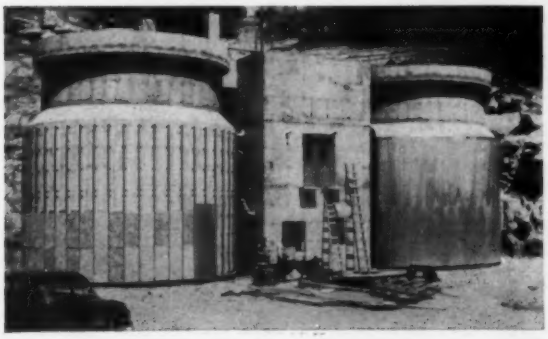
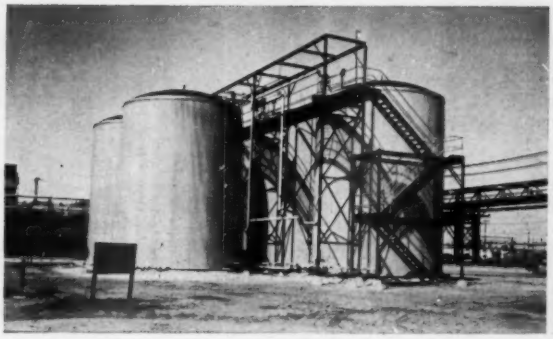


Fig. 7. (*Below*) Sewage digester tanks at a state hospital in Indiana being insulated to maintain temperature at optimum value. Tank at the left shows how material is applied to concrete

Fig. 8. (*Below, right*) Five chemical storage tanks. Sheathing applied by this method is easily removed where necessary to connect additional lines





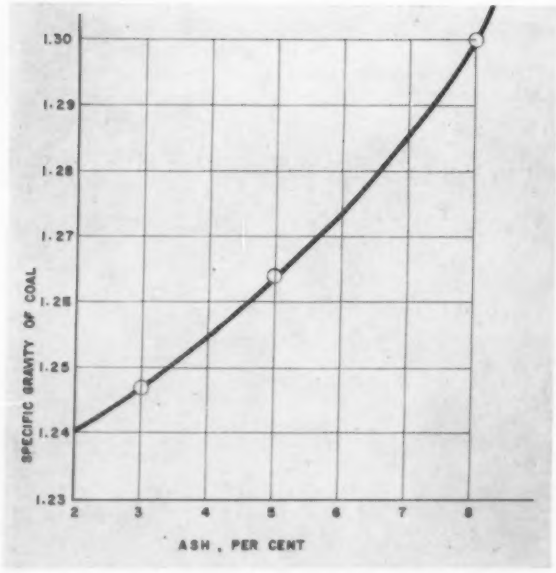


Fig. 1. Per cent ash in coal as related to specific gravity

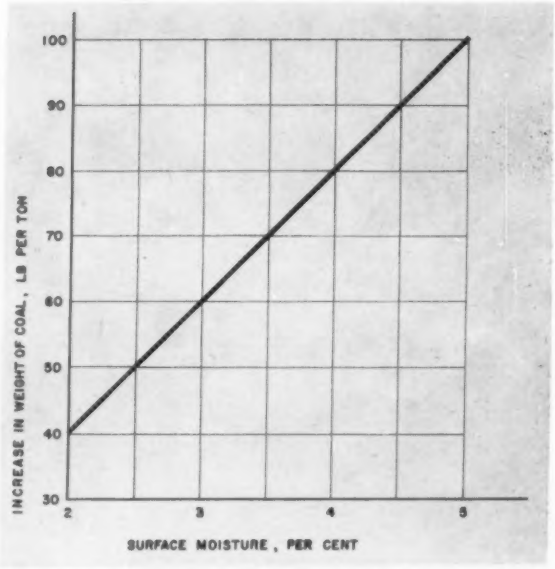


Fig. 2. Graph shows how moisture in coal affects its weight

Why Coal Weights Vary in Barges

By FRED M. REITER*

IN THE ARTICLE, How Much Does a Ton of Coal Weigh?, published in the January, 1956, issue of POWER ENGINEERING, the effect of moisture and ash content in coal was noted. In the June, 1956, issue, methods of determining the amount of coal in barges towed on rivers located in the coal producing and consuming areas was discussed. The possible errors in measurements of the displacement of the barges were pointed out in terms of the human factors involved.

It is believed, however, that most of the differences in weights determined by measurements made at the mine loading dock and the destination unloading dock are due to weather conditions. If the barge was loaded at the mine with dry coal, and it traveled through five days of heavy rain, the displacement weight would be augmented at the destination by the addition of the rain water accumulated in the coal.

This augmentation would be greatest with fine coal, where the moisture would be held on the coals' contiguous surfaces. With coarse coal, this water would tend to drain more readily; diminished capillary attraction would retain less water on the coal surfaces. If the movement of the coal occurred during a week in August, with dry, hot atmospheric conditions, the final weight would be lower. This would be particularly true if the coal were washed just before loading, and therefore began the journey with high moisture content. The amount of evaporation would be greater and thus a greater loss in weight would be observed at the destination.

The effect of the weather can be determined only by sampling and analyzing the coal at the points of measurement and determining the change in weight, gain or loss, by computation of the water content of the coal at both places.

Wet, Dry Days About Equal

Over a period of a year, weather effects should average out if the number of wet and dry days are about equal. The weights will not agree if the year is unusually wet or dry. In the year 1955, one coal shipping concern claimed that their annual audit showed a shortage between the barge displacement weights determined at the Kanawah River source and the final truck weights at the power station in Ohio; this amounted to over 500 tons on a gross shipping tonnage for the year of about 55,000 tons, or about 1.1 per cent of the gross tonnage. The year 1955 was an unusually dry year.

During one of these discussions, it was decided to check all of the factors involved in determining these weights. The results of the physical measurement of the displacement of the barge at the mine loading dock and the destination unloading dock at Cincinnati, Ohio, using a number of professional gagers, was discussed in a previous article.[1] At the same time as these measurements were being checked, samples of the coal were taken at the points of measurement: the Kanawha River loading dock, the Ohio River unloading dock at Cincinnati, and our O. H. Hutchings Station where the coal was burned.

This article examines these analyses in terms of their effect on the weight of coal contained into the barge studied. Adjustments are made for the moisture and ash content of the coal as sampled at the points of measurement, to the actual physical displacement tonnage determined by the gagers in their measurements. The adjustment data was taken from the article on How Much Does a Ton of Coal Weigh?, previously cited; in fact, Figs. 1 and 2 are segments of Figs. 4 and 5 of that article, expanded to magnify the range involved in these analyses.

The coal was sampled by taking a number of increments of coal off the end of the loading chute at the Kanawha River loading docks, and off the conveyor belt at the North Bend (Cincinnati) unloading docks at destination. Sampling off the chute and belt would give truer samples of the entire mass of coal in the barge. However, in order to note more effectively the effect of the weather on the coal, samples were taken across the surfaces of the loaded barge, in three areas: along the

[1] How Much Coal in That Barge?, by F. M. Reiter, POWER ENGINEERING, July, 1956.

* **Formerly, Fuel Engineer, Dayton Power & Light Co.**

Table I. Results of sampling coal at point of shipment, at point of unloading, and at power station where coal was used; differences indicated in section "D"

A. Samples from crest of coal in barge

Analysis item	Kanawha loading dock (per cent)	North Bend unloading dock (per cent)	Difference (per cent)
Moisture:			
Surface (air dry)	3.58	2.38	− 1.20
Total moisture	4.51	3.50	− 1.01
Ash	5.06	5.07	± 0.01
Volatile matter	36.56	36.87	± 0.31
Sulfur	0.98	0.98	0
Btu, as received	13,835	13,956	± 1.21
Btu, dry	14,488	14,462	− 26
Btu, ash-moisture free	15,299	15,264	− 35

B. Samples from loading chute and conveyor belt (barge loading and unloading)

Moisture:			
Surface (air dry)	3.39	2.43	− 0.96
Total moisture	4.19	3.64	− 0.55
Ash	5.49	5.61	± 0.12
Volatile matter	36.62	36.92	± 0.30
Sulfur	1.08	1.11	± 0.03
Btu, as received	13,769	13,821	± 52
Btu, dry	14,371	14,344	− 27
Btu, ash-moisture free	15,245	15,231	− 14

C. Samples from cars at Station (sampling off belt) Groups of cars in each composite sample

Analysis item	I (6 cars)	II (4 cars)	Weighted average
Moisture:			
Surface (air dry)	2.66	1.71	2.28
Total moisture	3.88	3.36	3.67
Ash	5.89	5.57	5.76
Volatile matter	35.90	36.65	36.20
Sulfur	1.09	1.06	1.08
Btu, as received	13,749	13,885	13,803
Bty, dry	14,303	14,367	14,329
Btu, ash-moisture free	15,237	15,246	15,241

D. Difference between average samples from Station and from loading and unloading docks

Analysis item	Kanawha loading dock (per cent)	North Bend unloading dock (per cent)
Moisture:		
Surface (air dry)	− 1.11	− 0.15
Total moisture	− 0.52	± 0.03
Ash	± 0.08	− 0.04
Volatile matter	− 0.42	− 0.72
Sulfur	0	− 0.03
Btu, as received	± 34	− 18
Btu, dry	− 42	− 15
Btu, ash-moisture free	± 16	± 30

Table II. How these coal analyses affect weight determination of coal in barges

A. Samples from top surfaces of coal in barge

	Moisture, per cent	Lb per ton	Ash, per cent	Specific gravity	Lb per ton*
At mine docks	4.51	90	5.06	1.264	64
At Cincinnati docks	2.38	48	5.07	1.264	64
Change	− 2.13	− 42	± 0.01	0	0

B. Samples from loading chute and belt conveyor

At mine docks	4.19	84	5.49	1.269	80
At Cincinnati docks	3.64	73	5.61	1.270	82
Change	− 0.55	− 11	± 0.12	± 0.001	± 2

* Computed from ratio of specific gravity of coal as given (1.267) to 2000 lb of pure coal of 1.22 sp gr, as given in source curve from which Figs. 1 and 2 are taken.

crest of the coal, down the middle of the barge and along the center of the slope of the coal on both sides of the barge. This was done at both the loading and unloading points, at the beginning and at the end of the approximately 250-mile voyage down the Kanawha and Ohio Rivers, a trip of about 5 days in transit.

The tabulations in Table I give the analyses obtained from the samples taken as described above.

Tests Check Closely

These tests checked almost too closely to prove much; but it must be admitted that the sampling and laboratory work was well done. The differences come within ASTM requirements for the same sample, let alone different samples taken many miles apart. This work was done during October 1955, a period of the year when it is too cool to get much evaporation of moisture, and too early for the rains that would have given wider variation.

We can, however, check these analyses with their effects on the weight determinations, even though the range is quite narrow. We can assume, in this discussion, that the ash and moisture are the impurities, and affect the weight and heat content of the coal in proportion to their percentage. We can use the curves of Figs. 1 and 2 in deriving the increments of change due to moisture and ash content. The tabulation in Table II summarize these determinations of the difference in weights because of the moisture and ash content.

Tabulations vs Tonnage

The tabulations in Table II can now be applied to the total tonnage measured for the barge. The average of all five measurements made, three at the Kanawha River loading docks and two at the North Bend unloading docks, was 886.3 net tons of coal contained in the barge, determined by the same methods of displacement. Applying the above change calculations to this tonnage, we would get the following variations in the weight of all of the coal in the barge:

Source of samples	Net change, lb per ton	For whole barge, 886.3 tons
For samples from top surfaces of coal	− 42	− 18.62 tons
For samples from chutes and unloading belt	− 9	− 3.99 tons

These figures show that the top surface changes are accentuated in drying; and they undoubtedly would show the greatest variation in wetting because of rains, snow, or inclement weather. However, the most accurate sampling is always throughout the entire mass of the coal, as would be obtained by chute or belt sampling. These final determinations should give a truer picture of the weight of the mass of coal in the barge.

The actual variation in the weight

Table III. Tabulation of the dry Btu content of all samples shows consistency

Top samples from barge	Btu per lb of dry coal	Variation from average Btu	Variation from average Per cent
At loading dock	14,488	± 89	0.62
At destination dock	14,462	± 63	0.44
Chute or belt samples			
At loading dock	14,371	− 28	0.19
At destination dock	14,344	− 55	0.38
Rail car average	14,329	− 70	0.48
Average of all	14,399		

Table IV. Comparison shows total heat purchase in coal about same at all points

	At the loading dock	At destination dock	Variation from loading dock, per cent
Top sampling			
Measured weight of coal, tons	889.96	885.81	− 0.47
Btu per lb. coal as received	13,835	13,956	± 0.88
Million Btu in measured weight	24,626	24,725	± 0.40
Chute and belt samples			
Btu per lb. coal as received	13,769	13,821	± 0.38
Million Btu in measured weight	24,510	24,486	− 0.10

of the coal in the barge, as measured by displacement at the two docks was as follows:

At loading dock on Kanawha River, as measured by three gagers:	889.96 tons
At unloading dock at North Bend, Ohio River, as measured by two gagers:	885.81 "
Variation, loss of weight due to loss of moisture	− 4.15 "
Variation, computed from variation in coal analyses	− 3.99 "

This author could not truthfully include any ash adjustments in these computations because the same coal was sampled all the way. In comparing different coals, the ash content would be important. If it had rained during transit, a more dramatic variation would show up. This example does serve to point out several facts worthy of consideration in judging the results of barge weight measurements:

1. The human factor of making the measurements is of primary importance,

2. Samples taken on the top surface of the coal in the barge should give the widest variation, because the surface will lose or pick up moisture as the weather varies, and,

3. Sampling off the chute or from a flowing belt that gives a true average of the mass of coal is essential for such computations.

In this study, several items appeared of added interest in comparing the results of all of these samplings and laboratory work.

A. The heat content of the "dry" coal remained very constant. Btu of the coal on a dry basis should not be affected by any changes in the moisture content of the coal whether rains increased the wetness and weight, or extreme hot dry weather reduced the moisture content of the coal. Tabulating the dry Btu content of all of the samples, we find the consistency shown in Table III.

This illustrates a case of good sampling and laboratory work. The top samples would be somewhat farther from the average because of hand sampling with a shovel and bucket even though many increments were taken.

B. The total heat purchase in the coal at any point should be the same because of the compensation of the weight with its Btu content on the as received basis. The results in this study give the comparison shown in Table IV, using the chute or belt sampling as giving the truest average sample.

It has generally been accepted that adjustments for moisture can be made on the as received basis, when the weights and samples are obtained at the same point at the same time. It is not generally easy to do this simultaneously, so that the dry basis is frequently used for the evaluation of the coal.

This study on the measurements of coal in barges on the river and the analyses of the coal at the various points serves to affirm or "place in evidence" some corroborating facts on the relationships between weights and other values and variations. While this single example may not be sufficient to "prove" these relationships, it was of interest to us.

First Atomic Submarine Engine Runs 66 Days at Full Power

SUCCESSFUL conclusion of an unprecedented power demonstration by an atomic ship propulsion reactor was announced recently by the U. S. Atomic Energy Commission.

The nation's first practical reactor power plant — the land-based prototype of the submarine *Nautilus* at the Commission's National Reactor Testing Station in Idaho — was routinely shut down on August 8, 1956, at the end of what is believed to have been the longest full power run ever completed by any type of propulsion plant — land, sea, or air.

On a single charge of uranium fuel (and using only part of that charge), the nuclear reactor located at the desert test facility operated at an average power of 100 per cent for more than 66 days and 66 nights. The test was designed to prove the reliability and stamina of pressurized water reactors for ship propulsion. The prototype of the reactor now in the *Nautilus* met the most demanding requirements placed upon it.

The test demonstrated the feasibility of nuclear power ships cruising at high speeds and without refueling for periods of time hitherto unattainable. Among the important benefits of the test was the obtaining of essential information on reactor performance during extended high power runs. This data will be used in the design of improved nuclear propulsion plants both for naval vessels and civilian nuclear power plants.

During the 66 days and nights of the test, Navy men assigned to the Naval Reactors Facility at the Idaho installation manned the submarine prototype plant in round-the-clock watches just as if they were in the *Nautilus* on a cruise. While the Navy ran the nuclear plant, engineers of the Westinghouse Electric Corporation which developed and built the reactor, studied its performance and gathered data.

The history-making prototype first produced power in May of 1953. Since that time, it has been used to supply data and advance the technology of pressurized water reactors. It was refueled in March, 1956, after two and a half years operation on the original uranium charge.

WOULD YOU LIKE TEAR SHEETS?

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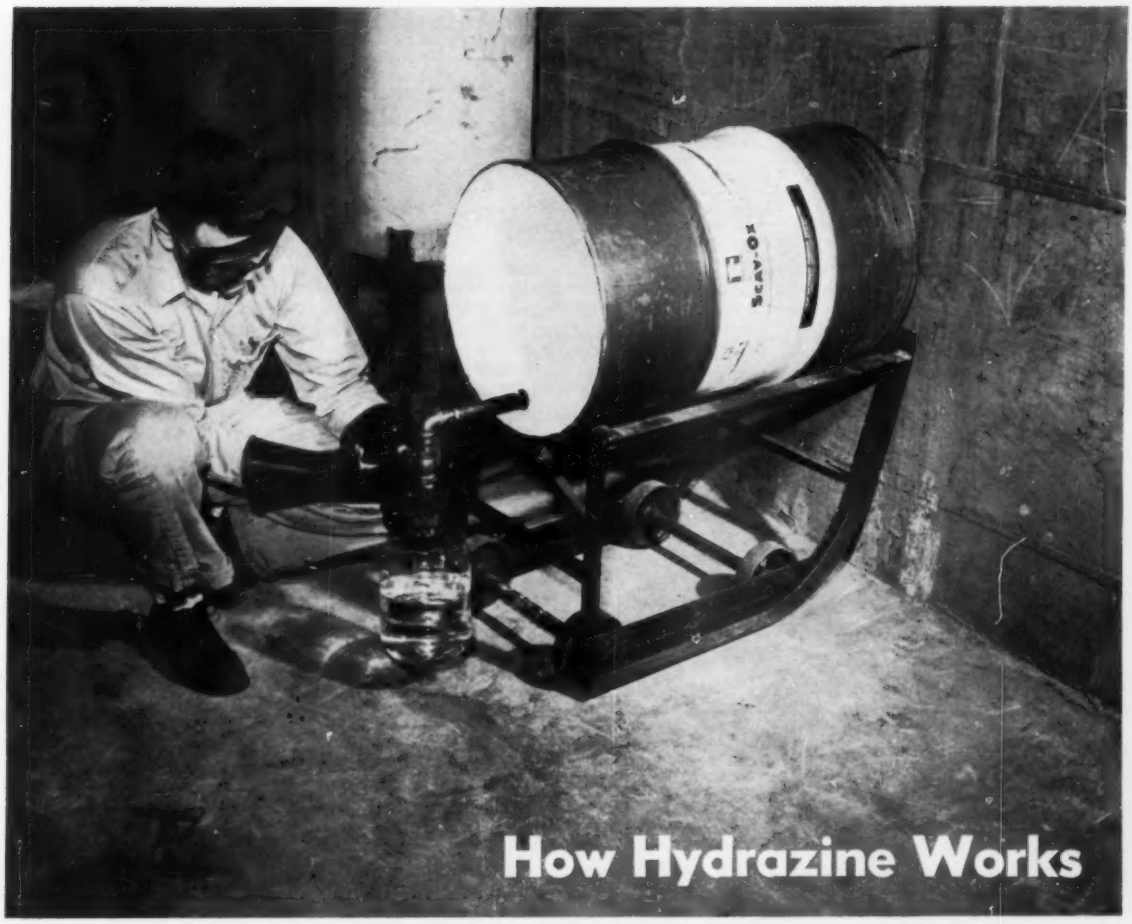


How Hydrazine Works

In previous articles* we reported users' experience with hydrazine. Many readers have asked for more information about it. Here is a brief outline of the properties and action of hydrazine in a boiler

IDEAL BOILER feedwater treatment would produce water of slight alkalinity, with no dissolved solids and complete absence of free oxygen. In present-day practice, chemicals control acidity, evaporation or ion exchange resins remove dissolved solids, and deaerating the feedwater by heat and also adding sodium sulphite reduce oxygen content.

Sodium sulphite, however, has certain disadvantages. It eliminates oxygen only if used to excess. It also adds dissolved solids to the water, either as the original sodium sulphite or as sodium sulphate after reaction with oxygen. These dissolved solids are a serious disadvantage, particularly in the new higher-pressure boilers. In all installations, the rising costs of equipment and repairs have made complete removal of free oxygen from feedwater an urgent necessity.

Hydrazine seems to offer another way of eliminating oxygen than sodium sulphite. Hydrazine, chemical formula N_2H_4, is a clear, water-white liquid. Its density and viscosity are close to those of water. It is hygroscopic, and it freezes at about 33.6 F and boils at 236 F at atmospheric pressure. It mixes completely with water and the lower alcohols, but is insoluable in saturated hydrocarbons.

Hydrazine has several properties that make it particularly suitable for boiler feedwater treatment.

1. It reacts with oxygen (O) to form nitrogen (N) and water (H_2O). Theoretically one lb of hydrazine will eliminate the corrosive effect of one lb of dissolved oxygen, but in practice it has been found that less than one lb hydrazine per lb of oxygen is required.

Hydrazine, in its original form or through its reaction products, does not add dissolved solids to the water. Therefore, in deoxygenating more efficiently, and in not adding solids to the water, hydrazine has considerable advantages over sulphite.

Some other advantages of hydrazine for water treatment are as follows:

1. Hydrazine contributes alkalinity to the water. A 1 per cent solution has a pH of about 9.9. Furthermore, the pH range at which hydrazine is most effective as an oxygen scavenger, i.e. pH 9.5 to 11, is also the preferred pH range for boiler water.

2. Hydrazine improves heat transfer by reducing ferric oxide scale to magnetic iron oxide, thus cleaning up boiler scale. It reduces iron and copper pick-up, so that sludge deposits in boilers are greatly reduced, and internal metal surfaces are left with a shiny black surface.

3. Hydrazine is used in very low concentrations and so it takes very little storage space and handling labor. As mentioned above, the hydrazine proportion is somewhere around 1 lb of hydrazine to 1 lb of dissolved oxygen, and as dissolved oxygen varies between 0.005 ppm to 0.1 ppm if the feedwater is deaerated, and up to 8 ppm if it is not mechanically

* CL & P Reports Experience with Hydrazine in Reheat Cycle, September 1955; Hydrazine Users Answer Questions on New Oxygen Scavenger, November 1955; South Street Reports on Hydrazine, September 1956.

deaerated, it can be seen that the amount of hydrazine required is very small.

4. Hydrazine has a tendency to raise the pH of boiler water and condensate returns, thereby reducing acidic corrosion of metals in both the steam generating and the condensing system.

Handling Precautions

Although high concentrations of hydrazine can be ignited, solutions containing 40 per cent N_2H_4 or less have no flash point. Most commercially available hydrazine is marketed as a solution of 40 per cent or less N_2H_4.

Hydrazine is toxic, and direct contact with the skin, also inhalation of the vapors, should be avoided. Some people develop dermatitis upon prolonged contact with small amounts of hydrazine, and so if hydrazine is spilled on the skin it should be washed off at once with plenty of water.

In general, if sufficient ventilation is provided to prevent a noticeable odor of hydrazine, no exposure damage will be suffered.

Hydrazine Feed

For industrial plant boilers, hydrazine solution is usually fed continuously into the feedwater line between the outlet of the deaerator and the intake of the boiler feedwater storage tank. With this arrangement a chemical proportioning pump is used to inject the solution into the line. In low pressure heating boilers, hydrazine is most simply applied in batches. A double valved piping connection can be fitted to the outside of the boiler at a convenient point above the water line. The upper valve is opened and the correct amount of hydrazine solution is poured into the pipe. Then the upper valve is closed and the lower one opened, and the hydrazine is thus dropped into the boiler.

Hydrazine usually comes in metal drums or smaller containers. The photograph shows it being withdrawn from a 30 gal drum.

Testing

The simplest type of testing equipment for hydrazine is a color comparator that shows the hydrazine content of boiler feedwater in fractional parts per million. These instruments are similar in price and type to other color comparators widely used for pH measurements, chlorine testing, etc. For large installations, precision instruments are available, though these are naturally more expensive than the simple color comparators.

Semi-Automatic Repair Line Cuts Motor Downtime

MOST FIRMS, in addition to a regular stock of spare parts, usually carry complete replacement motors for machines that are sufficiently important; i.e. machines whose breakdown would shut down a whole production line.

This system was good enough when there were only a few vital motors in a plant. Nowadays, however, with automation on the increase, production lines depend on successful functioning of every motor in the line.

If a firm has to keep a replacement for every motor in the plant, the cost of the spare motors, together with the financial loss of so much tied-up capital, would be quite prohibitive. As a result, there is a growing need for a repair service that will enable a manufacturer to get a faulty motor repaired very rapidly.

A newly opened, semi-automatic repair line at General Electric Co.'s Chicago Apparatus Service Shop should go a long way toward satisfying this need. In this new line, repair time has been cut by more than 50 per cent. Motors up through 50 hp can be diagnosed, disassembled, cleaned, rewound, rebuilt, tested and be ready for delivery in 8 hrs. This compares with 19 hrs previously required for similar motor service.

When a motor for repair first arrives in the shop, trained personnel immediately disassemble it, examine the parts, and then make a diagnosis. After necessary data is recorded, the coil department is immediately notified, so that coils can be manufactured and be ready for the winders by the time the stator arrives in that section.

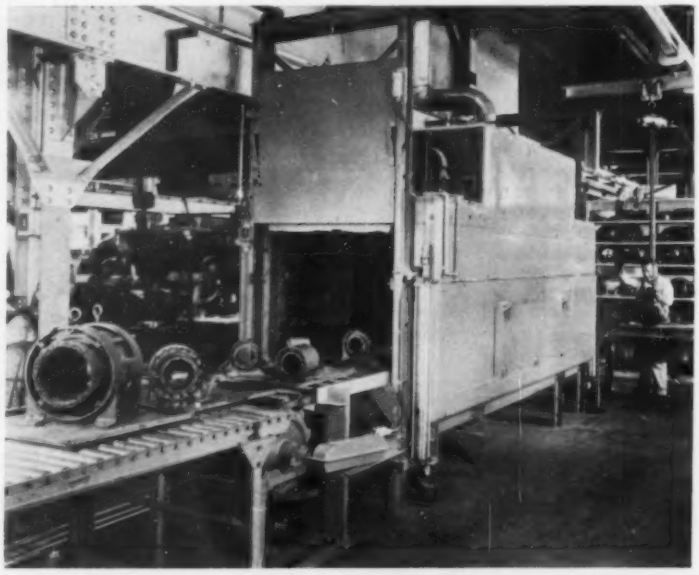
All motor parts are then thoroughly cleaned in a degreasing agitator, after which they are baked out in an oven to destroy the old winding and make its removal easy. The stators are then sandblasted to remove old paint and scale.

New coils, with high temperature insulation, are then inserted in the stator slots. Polyester slot cells are used for standard rewinding jobs, but glass, silicone, and epoxy treatments are used when required.

Once rewound, the winding is impregnated with a new fast-drying varnish. This varnish allows bake time to be reduced from 6 to 2 hrs. Baking is a completely automatic operation. The motors pass through a recycling, high-velocity gas oven on a conveyor. The oven unit indexes every half hour, and with a fast recuperating power, the oven regains its temperature loss in a few seconds after the doors open and close. The illustration shows the oven in use.

After baking, the motor is reassembled and painted and then moved by conveyor to the test bench, where the motor is simultaneously given a running test, phase balance check, and high potential test.

Then the motor is delivered to the customer, with the whole operation having taken less than 8 hrs.



Completely automatic oven, used as part of regular motor repair production line, cuts bake time for rewound stators 6 to 2 hrs. Wound stator dipped in special varnish is placed on oven's conveyor. Unit indexes every half hour, opens doors, takes fresh stators, moves out finished ones for assembly

In a water conditioning service... results make the difference!

W. H. & L. D. BETZ, Philadelphia, Pa.

Power Engineering handbook

Tips on Turbine Generator Maintenance *

Before Starting Up

Drain the steam supply line, steam chest and casing. This will help prevent slugs of water from entering the turbine and overloading the thrust bearing with accompanying damage to blading, seals and diaphragms.

Oil Supply should be adequate. Check the oil reservoir.

Auxiliary Oil Pump should be operating.

Trip Throttle Valve should be free — check to make sure it is not frozen.

Shaft Turning Gear, if installed, should be used to gradually warm up the turbine rotor before the unit is brought up to speed.

After Shutting Down

All Valves should be closed tight to prevent steam from entering the casing. Check the throttle valve, line stops, exhaust valve, and gland sealing valves. Steam entering through the gland seal line while the rotor is stationary may direct enough heat on a wheel hub to loosen the wheel. A leaky valve can also cause corrosion of blading and the shaft under carbon packing rings during an extended shut down.

Shaft Bows are usually due to heat left in the turbine after shut down, and not necessarily to steam leaks. They can result in a permanent bend if the turbine is operated incorrectly. Best bet is to operate the turbine at slow speeds for an hour or more to work the bow out. If a shaft turning gear is installed on your unit, use it after shut down until all the heat in the turbine is dissipated.

Keep Your Oil System Healthy

A turbine's lube oil supply is like the life blood in a human being. When anything goes wrong with it, there's trouble ahead.

To prevent lube oil trouble, make sure your lube oil is the type specified by the turbine manufacturer.

Keep all joints and oil seals tight to prevent water from entering the lube oil.

Water washes out anti-rust and oxidation inhibitors.

Don't wash down units with a hose

If you do have water in your lube oil, check for the following:

1. Low oil temperature.
2. Gland leakage into bearings.
3. Oil cooler leakage.
4. Auxiliary oil pump gland leakage.
5. Oil tank vents plugged.

Keep dirt out of the lube oil. On geared turbine generator units, dirt such as fly ash or sand can wear out a gear rapidly. Dirt can also fill the flexible coupling, gum up operating cylinders, etc.

Oil temperature should be about 120 F on leaving the oil cooler; if the oil temperature is too low, moisture will condense on the inside of the drain piping and the oil reservoir, causing rust to form. These rust deposits may then break loose and plug oil orifices, or accumulate in pilot valves and operating cylinders, causing erratic operation.

A well-planned inspection and maintenance program can prevent unscheduled shut down and repair headaches. The first internal inspection should be made after one year's operations. Assuming normal conditions were found, the second inspection should be scheduled about a year from the first. Future inspections should then be scheduled on the basis of the results found in the second inspection.

Time limits — inspections should be made at least every two years.

Flexible couplings should be inspected every year.

Here are a few of the important items that should be inspected:

1. Turbine rotor (generator rotor need not be removed unless there is an indication of damage or oil on the windings).
2. Nozzles.
3. Blading.
4. Bearings (turbine and generator).
5. Shaft packing.
6. Trip throttle valve, control valves and the entire governing system.
7. Auxiliary oil pump and associated controls.
8. Generator end bells.

If your unit is a geared unit, also inspect the following:

1. Gears
2. Pinions
3. Gear Bearings

Maintain an Accurate Daily Log

The most important reason for maintaining a daily log is that the operator is always aware of any changes — he doesn't have to rely on memory. The log also serves as a valuable record which can indicate causes of trouble.

Turbine

Initial steam pressure
Initial steam temperature
First stage pressure (and other stages, if gages are supplied
Vacuum or Exhaust pressure
Governor oil pressure
Bearing oil pressure
Bearing drain oil temperature
Temperature of oil entering and leaving cooler
Gland seal pressure
Oil level
Steam flow
Extraction flows
Condensate flow
Time and date of readings
Remarks section: Noise and vibration

Generator

Air cooler temperatures
Frequency
Kilowatt load
a-c Voltage
a-c Current
Power factor
d-c Voltage
d-c Current

Trouble symptoms can lead to big maintenance problems if not corrected. Check them immediately.

Insufficient Capacity

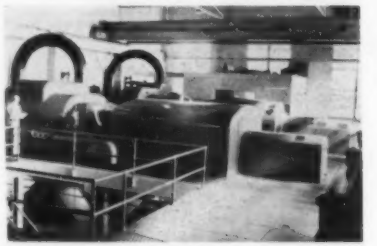
Possible causes are:

1. High exhaust pressure or loss of vacuum.
2. Low initial steam pressure or temperature.
3. Governor control linkage misadjusted, binding or worn.
4. Incorrect governor valve leads.
5. Blading plugged by carry-over.
6. Blading eroded or damaged.

Insufficient Frequency

Assuming the turbine is not paralleled with other units, the possible causes are:

1. Low initial steam pressure or temperature (if running at maximum load).
2. High exhaust pressure or loss of vacuum.
3. Governor control linkage misadjusted, binding or worn.
4. Governor load limit control set too low.
5. Incorrect governor valve leads.
6. Overbleeding extraction turbines.
7. Blading plugged by carry-over.
8. Blading eroded or damaged.



11,500 kw turbine generator recently installed by the North Carolina Municipal Power Department

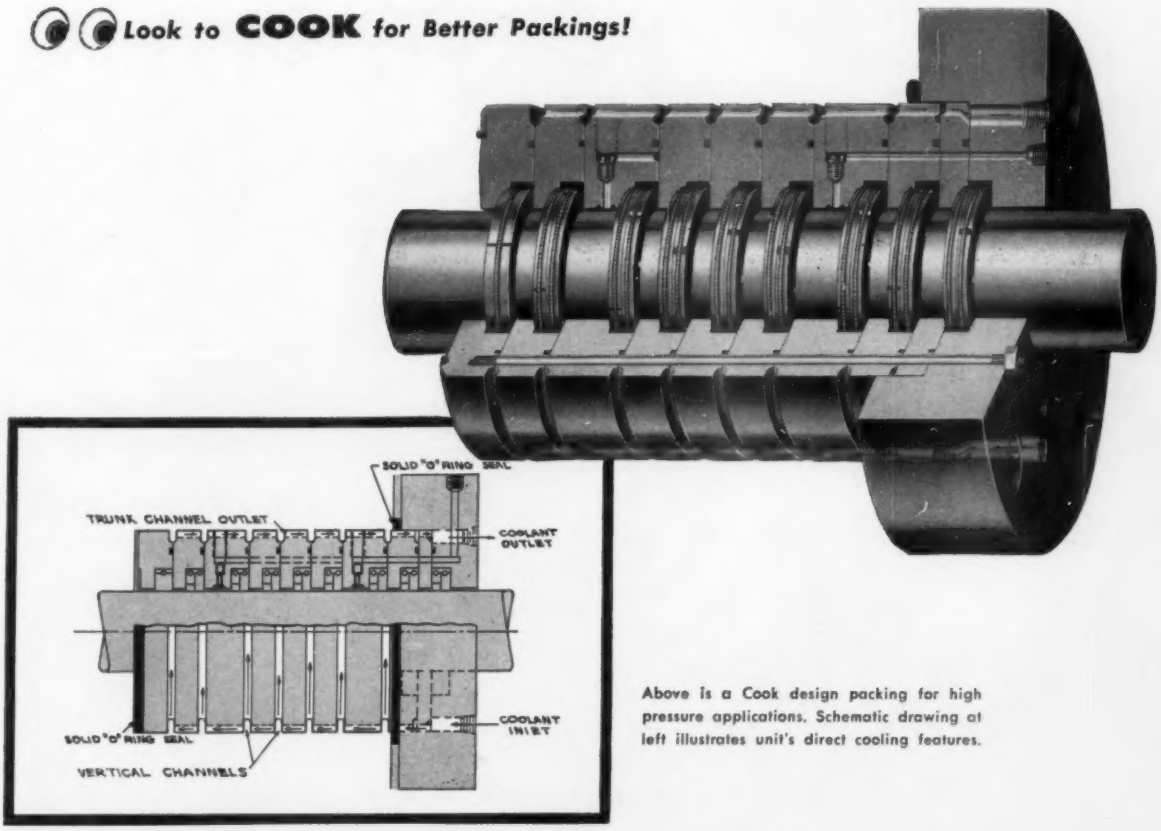
* From Steam Turbine Division, Worthington Corp.

POWER ENGINEERING HANDBOOK

fold along this line—outside edges toward you

cut along this line

Look to **COOK** for Better Packings!

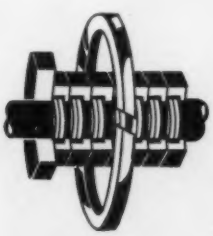


Above is a Cook design packing for high pressure applications. Schematic drawing at left illustrates unit's direct cooling features.

Cook direct-cooling designs take heat off high pressure packings

IN the design shown — which is typical of Cook pioneering in direct cooled high pressure packings — the coolant enters a trunk line at the bottom and passes through multiple vertical channels to an outlet trunk line at the top. Coolant connections are handled without arranging separate inlets or outlets through the stuffing box.

Cook's creative design engineering provides almost unlimited possibilities for direct cooling on existing packings as well as on new designs. For a solution to your high pressure packing problems in the 1,000 to 30,000 pounds per square inch range, write to C. Lee Cook Company, 904 South Eighth Street, Louisville, Kentucky.



C. LEE COOK COMPANY

A Subsidiary of Dover Corporation

Rings and Packings Since 1888

For more data circle 552 on Post Card

Be Sure Your Oil Drum Chocks Are Safe

By F. E. RILEY

STANDARD DRUMS for the containing of oils and industrial liquids in bulk are usually placed on a stand which raises them to a convenient level, as shown in Fig. 1. The drum will roll off the surface of the stand if it is not wedged in some way. A common method of wedging drums is to use any odd bits of wood or other material that happens to be available. Some of these makeshift wedges are a potential source of accidents, because they become dislodged and the drum rolls off the supporting stand.

Device shown at A in Fig. 1 will prevent the drum rolling. It is a length of scrap steel strip bent to an arc and with the ends bent down at an angle. The section of the steel should be about 2½ in. as a minimum.

A cheaper form of wedge is shown in Fig. 2. A single lump of wood, A, measuring about 6 in. square and 2 in. thick

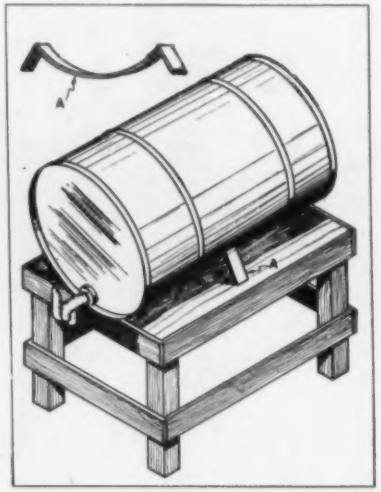


Fig. 1. One-piece metal chock gives great stability

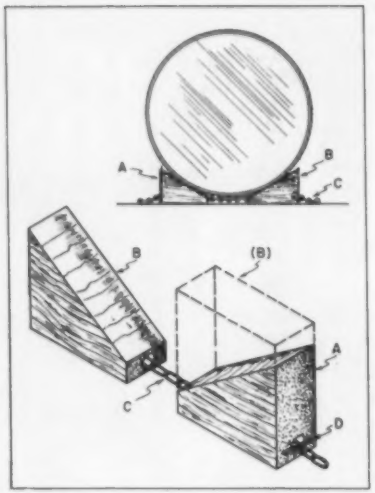


Fig. 2. This arrangement allows wood wedges to be removed so that the drum may be rolled easily from the supporting platform, without lifting

is sawed approximately diagonally to form two wedge-shaped pieces, as at B. The wedges are drilled through horizontally to clear the chain, C. The two blocks can be fitted snugly to the oil drum periphery and cannot slide horizontally because of the chain holding them the correct distance apart. The chain is locked in place by passing rods or nails, D, through the chain links.

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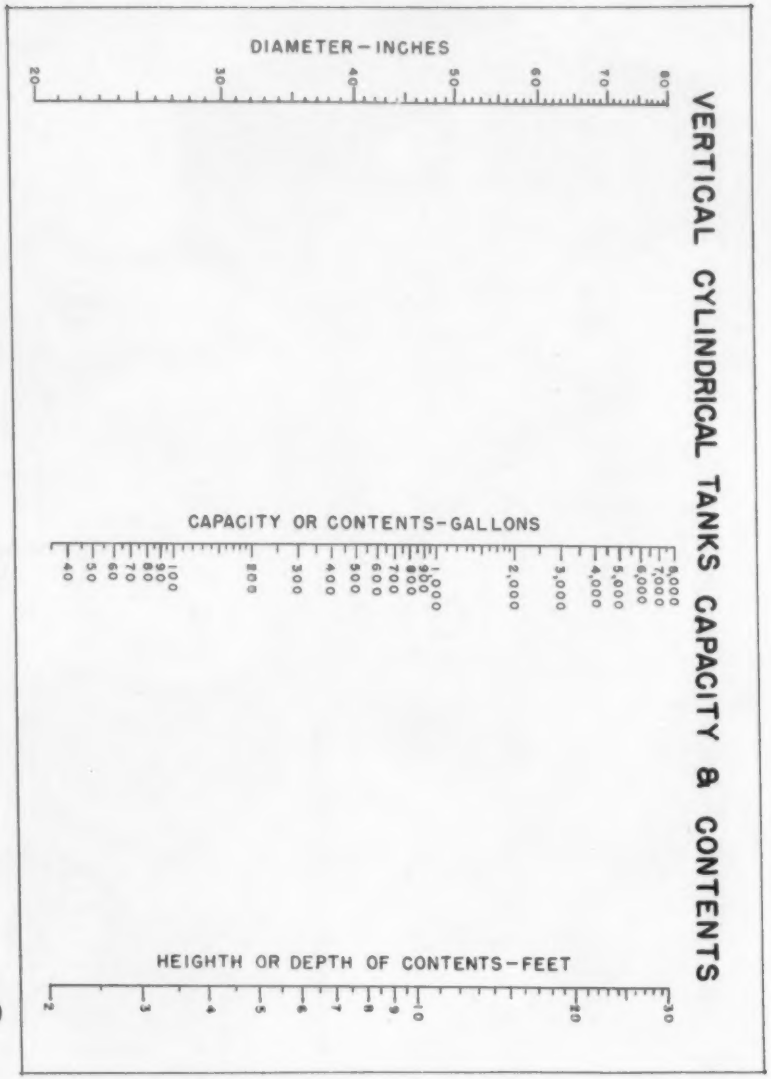
fold along this line—outside edges toward you



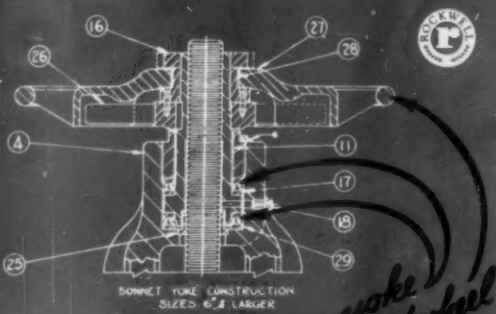
This handy chart by Earl C. Davis can be used for quick figuring of capacity and contents of vertical cylindrical tanks

C.F.R.
Edward tests both seats simultaneously for tightness – no leakage into bonnet with these gate valves. Check these features. H.C.K.

ROCKWELL BUILT
Edward Valves

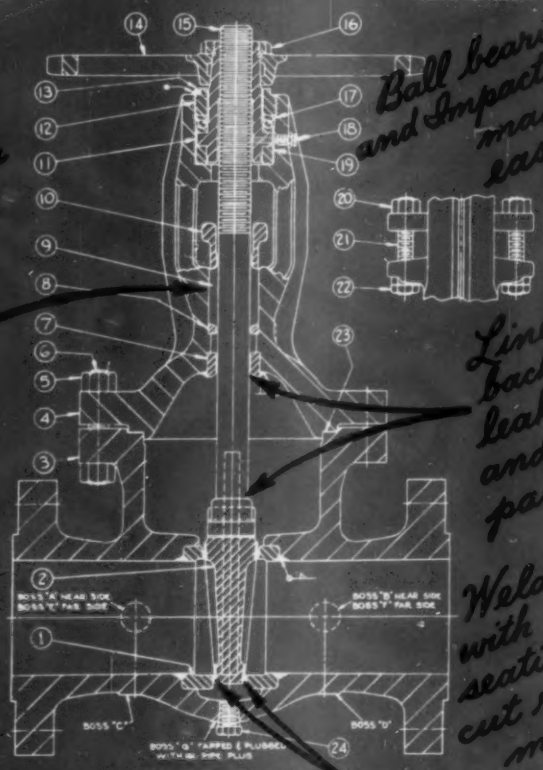
Deep packing chamber and preformed EValpak packing stop stem leakage and pitting – lower maintenance

Welded-in wedge guides are accurately aligned with seats, wedge, and each other so that wedge travels almost to a closed position before touching seats – reduces wear, extends sealing life of seating surfaces.



BONNET YOKE CONSTRUCTION
SIZES 6" & LARGER

Ball bearing yoke and Impactor handwheel make operation easy in larger Edward gate valves.



Line contact backseat makes leakproof seal and protects packing.

Welded-in seats with Stellited seating surfaces cut repair and maintenance costs.

SECTION SHOWING CLOSELY GUIDED WEDGE IN GUIDE RIBS

WEDGE & STEM TEE HEAD CONNECTION

Edward makes a premium gate valve – a good investment for lower operating expenses.

Let's specify them

LIST OF MATERIAL
QUANTITIES ARE FOR 1 GATE VALVE

PIECE No.	NAME OF PIECE	No. REQD.	MATERIAL	SPECIFICATIONS	EDW. No.
1	SEAT	2	STAINLESS STEEL RING	STELLITE FACED	117
2	WEDGE	1	STEEL	STELLITE FACED S & L (LARGER	
3	BODY	1	CAST STEEL GRADE WCB	A.S.T.M. A216 (CARBON)	102
			CAST STEEL GRADE WC6	A.S.T.M. A217 (C-½ MOLY)	209
4	BONNET	1	CAST STEEL GRADE WCB	A.S.T.M. A216 (CARBON)	102
			CAST STEEL GRADE WC6	A.S.T.M. A217 (C-½ MOLY)	209
5	BONNET STUD NUTS		STEEL	A.S.T.M. A194	
6	BONNET STUDS		ALLOY STEEL	A.S.T.M. A193	
7	BONNET BUSHING	1	EVALLOY	A.S.T.M. A182 F6	212
8	JUMP RING	1	STEEL	EVALIZED	123
9	PACKING		EVALPAK	6 RINGS MINIMUM	
10	GLAND	1	STEEL	A.S.T.M. A105	111
11	YOKE BUSHING	1	BRONZE	A.S.T.M. B143 ALLOY 2	432
12	YOKE BUSHING LOCKNUT	1	EVALLOY	A.S.T.M. A182 F6	212
13	YOKE BUSHING LOCKPIN	1	STEEL		
14	HANDWHEEL	1	MALLEABLE IRON	A.S.T.M. A197 CLASS B	322
15	STEM	1	EVALLOY	A.S.T.M. A182 F6	212
16	HANDWHEEL LOCKNUT	1	STEEL	A.S.T.M. A108	121
17	UPPER BALL BEARING	1	BALL THRUST	S.A.E. STANDARD	
18	ALEMITE FITTING	1	BUTTONHEAD INDUSTRIAL TYPE		
19	LOWER BEARING PLATE	1	STEEL	EVALIZED	
20	GLAND BOLT NUT	2	STEEL (CLASS 1 OR 2)	A.S.T.M. A194	
21	GLAND BOLT	2	ALLOY STEEL GRADE B7	A.S.T.M. A193	
22	JAM NUT	4	STEEL (CLASS 1 OR 2)	A.S.T.M. A194	
23	GASKET	1	IRONSTITE (NO Asb. MAT.)	ARMCO IRON	
24	PIPE PLUG	1	STEEL		
25	SEALING WASHER	1	STEEL	EVALIZED	123
26	CROSS ARM	1	CAST STEEL	A.S.T.M. A216	102
27	IMPACTOR HANDWHEEL	1	CAST IRON	A.S.T.M. A126 CLASS A	
28	HANDWHEEL BUSHING	1	BRASS	COMMERCIAL QUALITY	
29	LOWER BALL BEARING	1	BALL THRUST	S.A.E. STANDARD	

Edward builds Globe and Angle Stop, Non-Return, Check, Stop-Check, Gate, Blow-Off, Mudline, Relief, Hydraulic, Instrument, Gage, and Special Valves and Strainers.

EDWARD VALVES, INC.
SUBSIDIARY OF ROCKWELL MANUFACTURING CO.
EAST CHICAGO, INDIANA

CAST STEEL GATE VALVE
GENERAL ASSEMBLY

DRAWN [illegible]
CHK'D. O. [illegible]
APP'D [illegible] DATE [illegible]

DRAWING NO. AE-3207-1

Fig. 1. Largest corrosion-resistant tank in photo weighs only 150 lb, holds 600 gal. Wide range of sizes.

Is Corrosion-Resistance Important to You?

FOUR TANKS shown in Fig. 1, and the various ducts, hoods and fittings of Fig. 2 indicate the advances that are being made in the development and use of corrosion-resistant material that is light in weight. Here the material is a polyester glass reinforced plastic, tough and of high strength. It is said to have corrosion resistance to oxidizing acids and many chemicals that is far superior to stainless steel. The cost also is reportedly substantially less. This particular line is being offered by Haveg Industries, Inc.

A wide range of standard fittings and ducts round and rectangular in section is offered, but any size and shape of duct hood or stack can be made, according to the manufacturer.

Fig. 2. Different ducts, hoods and fittings now available in lightweight corrosion-resistant plastic

fold along this line—outside edges toward you

Make Your Wire Rope Last Longer

FOR LENGTHENING the life of wire rope:
(1) Shift the rope periodically to distribute wear,
(2) Reverse the position of the rope on the drum.

According to Wickwire Spencer engineers, wire rope used for hoisting is usually subjected to the most severe wear at two or three critical points along its length. As a result, these spots wear out prematurely and make rope replacement necessary even though the major portion of the rope may still be serviceable.

These points of critical wear include that portion of the rope in contact with the sheaves as the load is picked up, and also that point of the rope which winds on the drum as the load is accelerated. The section of rope which contacts the drum flange and rises to the next layer on the drum in multiple layer winding is also subject to excessive wear and distortion.

The reason for the greater degree of wear on the rope in contact with the sheaves is that during the pick-up period the rope speed is being increased, and this acceleration may cause slippage between the rope and the sheave. This acceleration also increases the tension in the rope and this in turn increases the radial pressure between the rope and the sheave, causing greater pressure and rope wear.

Practical approach to distributing such severe wear over a longer length of rope is to shift the rope during its life. This may be accomplished by purchasing slightly longer rope than required in the beginning so that as the rope is used, a pre-calculated length can be cut off periodically. This will advance the rope so that those sections that have not previously been subjected to severe service will now be placed in those spots subject to greatest damage, and those portions which have been subjected to severe wear will be moved on to an area of lesser wear.

When it is possible to institute a procedure such as this, rope life can be considerably increased.

Another method occasionally followed on some operations, which will distribute wear, is to reverse the rope. This involves detaching the rope from the drum and making the drum-end the load-end and vice versa.

This, however, will not result in greater service if the point of greatest wear is near the midpoint of the rope. Reversal of the rope under such condition would not change the position of the point of greatest wear, and so would not lengthen the life of the rope.

Gloves Resist Oils, Gasoline, Acids

THESE GLOVES for workers handling gasoline and oil products have a special coating based on Bakelite vinyl resins to resist oils, gasoline, acids and other chemicals. The flexible coating is fused to a strong, comfortable fabric liner. The gloves stay flexible after a 24-hour bath in solvents such as gasoline, kerosene, naphtha, mineral spirits and petroleum oils, the manufacturer states. Want More Information? Write the Editors, or jot Work Gloves on the postcard inserted elsewhere in this issue, and mail.

cut along this line

Return line corrosion resulting from carbonic acid

ALL pHOULED UP

pH—a symbol denoting the negative logarithm of the concentration of the hydrogen ion in gram atoms per liter. This scale permits the expression of both acidity and alkalinity in units which can be measured by means of a hydrogen electrode.

That's what chemists say about it. Some of the things that power plant engineers say about it are best left unquoted.

A low pH value in condensate can cause a power plant engineer a lot of trouble. When the pH value of water goes below 6.9, it's becoming acid—and when it's acid, it's highly corrosive. Then it begins to eat away at the internal surfaces of pipes and return lines.

Corrosion caused by low pH is most effectively prevented by the application of Dearborn's FILMEEN.* By forming a non-wettable, monomolecular coating on all metal surfaces with which treated steam or condensate come in contact, FILMEEN provides a protective, corrosion-inhibiting barrier between water and metal. By preventing the carbonic acid from touching the metal surfaces, FILMEEN thus keeps the lines corrosion-free.

When you find rusty condensate coming back to your boilers, it's time to see your Dearborn representative. He'll show you how FILMEEN will reduce excessive maintenance, avoid shutdowns and protect valuable equipment in your power plant.

**FILMEEN—U. S. Pat. No. RE-23614 reserves to Dearborn Chemical Company and its licensees exclusive right to the use of octadecylamine for water treatment.*

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How to Measure Air Volumes

By JOHN D. CONSTANCE

WHEN USING a pitot tube in ductwork to measure flowing air, the velocity pressure read from the manometer may need to be corrected for density of the flowing medium. Air velocity may be determined from the following equation:

$$1096.2\ (h^{\frac{1}{2}} \div d^{\frac{1}{2}})\ \text{ft per min}$$

where h is velocity pressure read on the manometer, in. water gage: d is density of air at measuring station, lb per cu ft.

However, the chart reproduced here, may be used to speed up the matter of conversion. For example, air with a density of 0.07 lb per cu ft has a relative density of

$$(0.07 \div 0.075) = 0.93$$

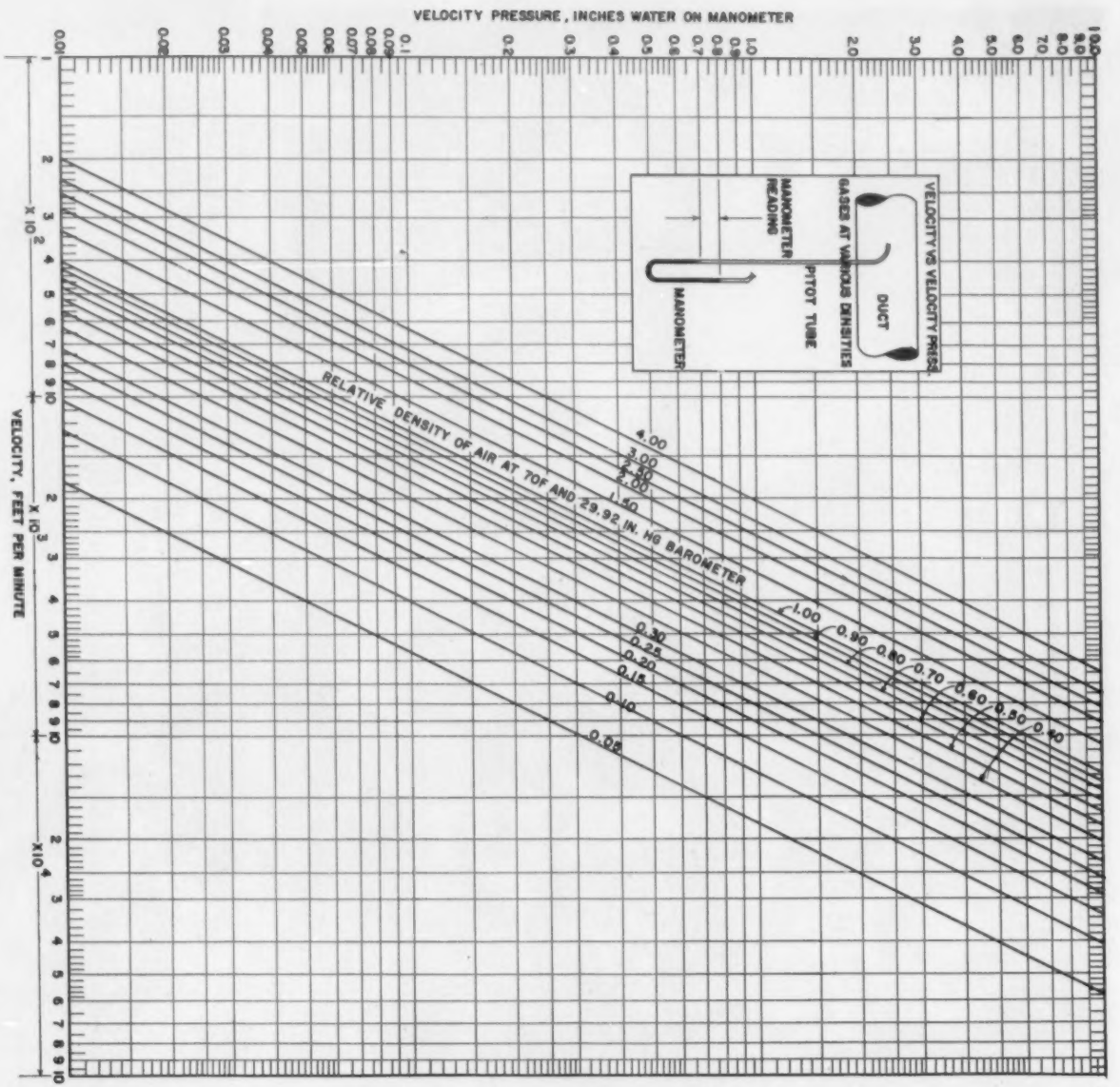
If this air is flowing through a duct and the manometer reads 0.07 in. water gage, the chart reads an air velocity of 1110 ft per min.

Air density d may be determined by the following formula:

$$d = (1.325 \times B) \div (460 + t)\text{lb per cu ft}$$

where B is barometric pressure, inches of mercury; t is flowing temperature, deg F.

For more accuracy, in case static pressure in duct at measuring station exceeds ¼ in. Hg, that pressure must be added to the barometric pressure (in inches of Hg) and this revised barometric pressure must be used in obtaining the air density in the duct at the measuring station.



Instruments for Load Analysis

2 New Ranges for General Electric Inkless Recorder Help You Get More Accurate Checks of Electrical Loads

FOR IMPROVED LOAD ANALYSIS, General Electric's CF-7 hook-on recorder now has a total of nine ranges, greatly increasing the flexibility of this already versatile inkless recorder. Easy and accurate recordings can now be made over ranges of 15/30/75/150/300/750 amperes a.c. and 150/300/750 volts a.c. making the instrument suitable for a wide variety of applications.

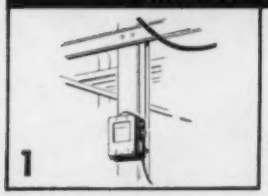
SIMPLE TO USE, the CF-7 measures either current or voltage without interrupting service. The current transformer is merely hooked onto the line. Molded in butyl, the hook-on transformer is ASA rated up to 8700 volts. For operating safety, the transformer secondary is short-circuit protected.

LIGHTWEIGHT AND PORTABLE, the CF-7 can be installed for recording either current or voltage in only four simple steps. (See explanation below.) Once installed, the recorder requires little servicing other than replacing record rolls.

3 WAYS BETTER for checking growing commercial and industrial loads, the CF-7 provides fast, convenient hook-on installation, inkless recording, plus the ability to operate continuously for 30 days without attendance.

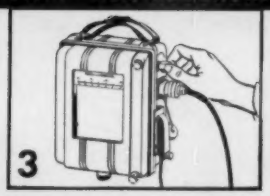
SEE FOR YOURSELF how the General Electric hook-on recorder can help solve coming electrical load problems. Write Section 582-16, General Electric Co., Schenectady 5, N. Y., and ask for bulletin GEA-6104, or contact your nearest G-E Apparatus Sales Office.

FOUR-STEP INSTALLATION IS FAST AND EASY—FOR RECORDING CURRENT . . .

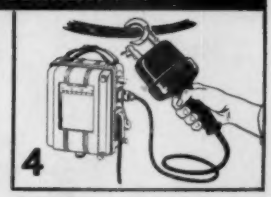


MOUNT RECORDER on pole or other convenient location. Connect recorder to either 120- or 240-volt power supply (50 or 60 cycles).

CONNECT TRANSFORMER LEAD to special socket on the side of the recorder. Extension leads are available in 10- and 50-foot lengths.



SELECT PROPER RANGE by setting selector switch on the side of the recorder for any one of six current ranges—15, 30, 75, 150, 300, 750 amperes.



HOOK CURRENT TRANSFORMER on the conductor which is to be checked. Butyl-molded transformer is ASA rated up to 8700 volts for safety.

GENERAL ELECTRIC

For more data circle 555 on Post Card

CONSTRUCTION NEWS

Birmingham, Ala. — The Alabama Power Co., a subsidiary of the Southern Co., has plans under consideration for the construction of new generating facilities on the Warrior River, near here. Certificate of convenience and necessity has been requested from the Alabama Public Service Commission and application for a license has been filed with the Federal Power Commission. Plans call for the construction of a 300-ft high dam on the Sipsey Fork of the Warrior River and the installation of two generators with an ultimate capacity of 160,000 kc. Cost of new facilities reported to be $37,000,000.

Huntington Beach, Calif. — The Southern California Edison Co., 601 W. Fifth St., Los Angeles, Calif., has work under way on new power plant on 80-acre site recently acquired for the purpose on Highway 101 and Newland Street. Company plans to install two 200,000-kw generating units initially and ultimately has plans in view to make this power plant the largest in the company's system. Contract for steel framing of generating station has already been let to the Bechtel Corp., Vernon Branch, Los Angeles, Calif., in the amount of $4,750,000. Ultimate cost of new plant will represent an investment of $60,000,000.

Chicago, Ill. — The Commonwealth Edison Co., 72 West Adams St., has announced the purchase of a new steam turbine generating unit for its Joliet, Ill., power station. Initial capacity of new installation will be in excess of 300,000 kw and is expected to be placed in operation in mid-1959. The General Electric Company will build the turbine generator for the unit and Babcock & Wilcox will construct the steam generating section. New unit is the third of its size ordered by the Commonwealth system this year and raises company's generating capacity to a total of 1,595,000 kc. The new unit will cost an estimated $19,000,000, and is part of Commonwealth Edison's $600,000,000 construction program to be completed by 1959.

Decatur, Ill. — The Illinois Power Co., 134 East Main St., has arranged financing in the amount of $20,000,000, proceeds of which will be used to finance additions and improvements to generating stations, transmission lines and equipment along with other facilities through 1956. Company has ear-marked $26,000,000 for expansion through the last nine months of this year and another $30,000,000 for the year 1957.

Boonville, Ind. — The Aluminum Company of America, 1200 Alcoa Building, Pittsburgh, Penna., has work under way on the construction of a 150,000-ton aluminum smelting plant on the Ohio River. Facilities will include ingot-casting equipment, a carbon plant for manufacturing anodes used in the smelting process, machine and electric shops, and a large steam power plant and high pressure boiler installation with a capacity of 375,000 kw. Docking facilities are also contemplated in Warrick County near here. Project when completed will represent an investment of $80,000,000.

Topeka, Kan. — The Kansas Power & Light Co., has authorized a major expansion and improvement program through 1957 with construction expenditures expected to reach $15,300,000 this year and $13,815,000 in 1957. The budget for electrical facilities will be split up into $10,296,000 for generating equipment, $7,910,000 for distribution and substation facilities, $4,047,000 for transmission lines and $1,033,000 for miscellaneous wares.

Lexington, Ky. — The St. Joseph's Hospital, Sisters of Charity, 1701 Dixie Highway, has authorized plans for the construction of seven story hospital of reinforced concrete and brick. A large boiler plant with laundry facilities is planned. Proctor Ingles, 915 S. Limestone St., is consulting engineer. Cost estimated in excess of $4,250,000.

Minneapolis, Minn. — The Northern States Power Co., 15 S. Fifth St., is arranging financing in the amount of $15,000,000, and has filed application with the Federal Power Commission, the Securities and Exchange Commission and the Public Service Commission of North Dakota, for authority to issue bonds in that amount. Funds will be used in connection with current expansion, covering power plants, transmission lines and other miscellaneous operating facilities. Company budget for new facilities in 1956 will run in excess of $38,000,000, with an expansion and improvement program already budgeted for 1957–1958, in excess of $85,000,000.

Sayreville, N. J. — The Jersey Central Power & Light Co., Bangs Ave., Asbury Park, N. J., has authorized expansion of its Sayreville power plant. Installation of a second steam electric generating unit with initial capacity of 137,500 kw is planned and is expected to be in operation by late 1958. Cost of installation with all equipment will approximate an investment in excess of $25,000,000.

Toledo, Ohio — The Toledo Edison Co., Edison Building, Toledo, Ohio, has awarded a contract to the Westinghouse Electric Corp., Toledo Trust Building, for the installation of a new turbine generator and auxiliary equipment at company's local Bay Shore generating station. Work has also been started on a new plant addition to the main building measuring 100′ x 356′, generator, boiler, circulating water system and new substation facilities. Total estimate of cost when completed will be in excess of $22,000,000.

Portland, Ore. — The Pacific Power & Light Co., Public Service Building, has announced plans for a major expansion of company's Merwin hydroelectric project on the Lewis River, in southwest Washington. Preliminary work on the 45,000-kw expansion will begin shortly, with completion scheduled for the fall of 1958. A third generator is under consideration and when installed, will boost generating capacity to 150,000 kw. Initial installation will cost approximately $5,000,000.

Aliquippa, Penna. — The Jones & Laughlin Steel Corp., 3 Gateway Center, Pittsburgh, Penna., has authorized plans for boiler house alterations and improvements at company's facilities here. The Kuljian Corp., 1200 N. Broad Street, Philadelphia, Penna., has been appointed to engineer the work, which is reported to cost in excess of $500,000.

Chester, Penna. — The Philadelphia Electric Co., 1000 Chestnut St., Philadelphia, Penna., has plans under way for the installation of a second generating unit of 325,000-kw capacity at company's $110,000,000 Eddystone power station now under construction on the Delaware River, near here. The first unit is scheduled to be placed in operation by 1959, and the second, now being built by the General Electric Company is expected to be in operation by late 1959 or early 1960. Both units will be capable of producing enough power to supply the electrical needs of more than 1,000,000 homes.

Wilkes-Barre, Penna. — The General State Authority, 18th and Herr Streets, Harrisburg, Penna., is considering plans for the construction of an institution for defective delinquents, on local site. Work will include a large power plant, sewage and water distribution systems. Alfred Hopkins Associates, New York, N. Y., and Atherton & Davis, Wilkes-Barre, Penna., are the architects. Building will cost an estimated $9,000,000 when completed.

Bryan, Tex. — The City of Bryan, Tex., as previously noted in these columns, has authorized expansion of municipal power plant. Preliminary construction work on the foundations for new installation are under way and contract has been awarded to the General Electric Co., River Road, Schenectady, N. Y., to furnish and install a new 22,000-kw turbine generator. Plant is expected to be in operation by early 1959 and is reported to cost approximately $1,000,000.

El Paso, Tex. — The El Paso Electric Co., has announced a major expansion program over the next three years, to cost in excess of $45,000,000. Plans call for the installation of two new generating units, each with a rated capacity of 50,000 kw to be in operation by late 1957, construction of 115 miles of high-voltage transmission lines and facilities by mid-1958 and the possible addition of another generating unit of 80,000 kw by the fall of 1959. New facilities will more than double current capacity of company's system, serving the El Paso and Las Cruces, N. M., areas.

Manassas, Va. — The Prince William Electric Cooperative, 110 Main St., has authorized plans for a major expansion of facilities and distribution lines and is installing a 250-mile rural distribution line with additional headquarters facilities. Other system improvements are contemplated at a reported cost of $1,040,000.

Glenrock, Wyo. — The Pacific Power & Light Co., 920 S.W. Sixth Ave., Portland, Ore., has announced that they have awarded contract to Ebasco Services, Inc., 2 Rector St., New York, N. Y., to design and construct new power generating plant and transmission lines and auxiliary facilities for new installation planned here. Estimated cost of installation when completed reported to be approximately $22,000,000. Plant is expected to be in operation by early 1958.

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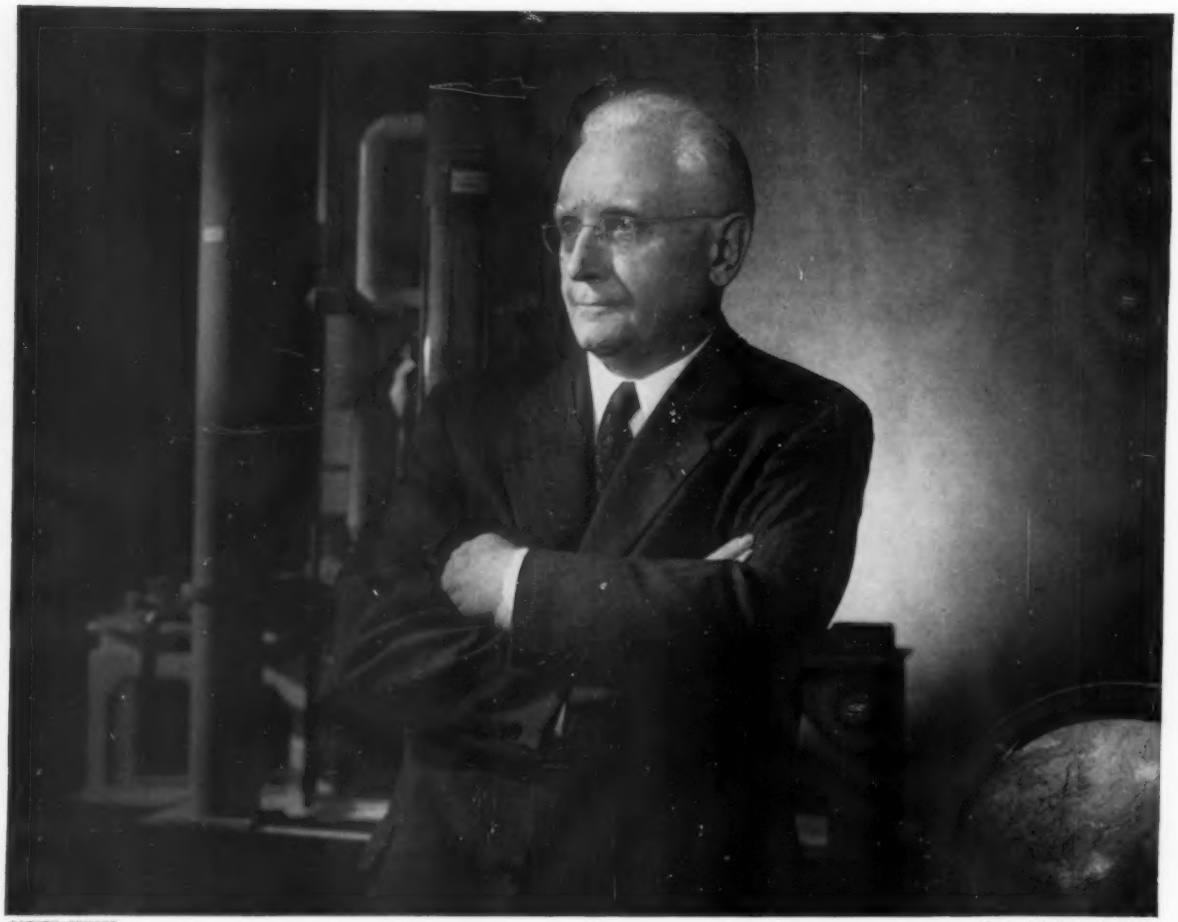

ALFRED IDDLES

Portrait by Fabian Bachrach

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"The Payroll Savings Plan, a truly 'All American' thrift program has been steadily winning employee approval all over the country. Employees of Babcock & Wilcox are an example of this fact.

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ALFRED IDDLES, ***President***
The Babcock & Wilcox Company

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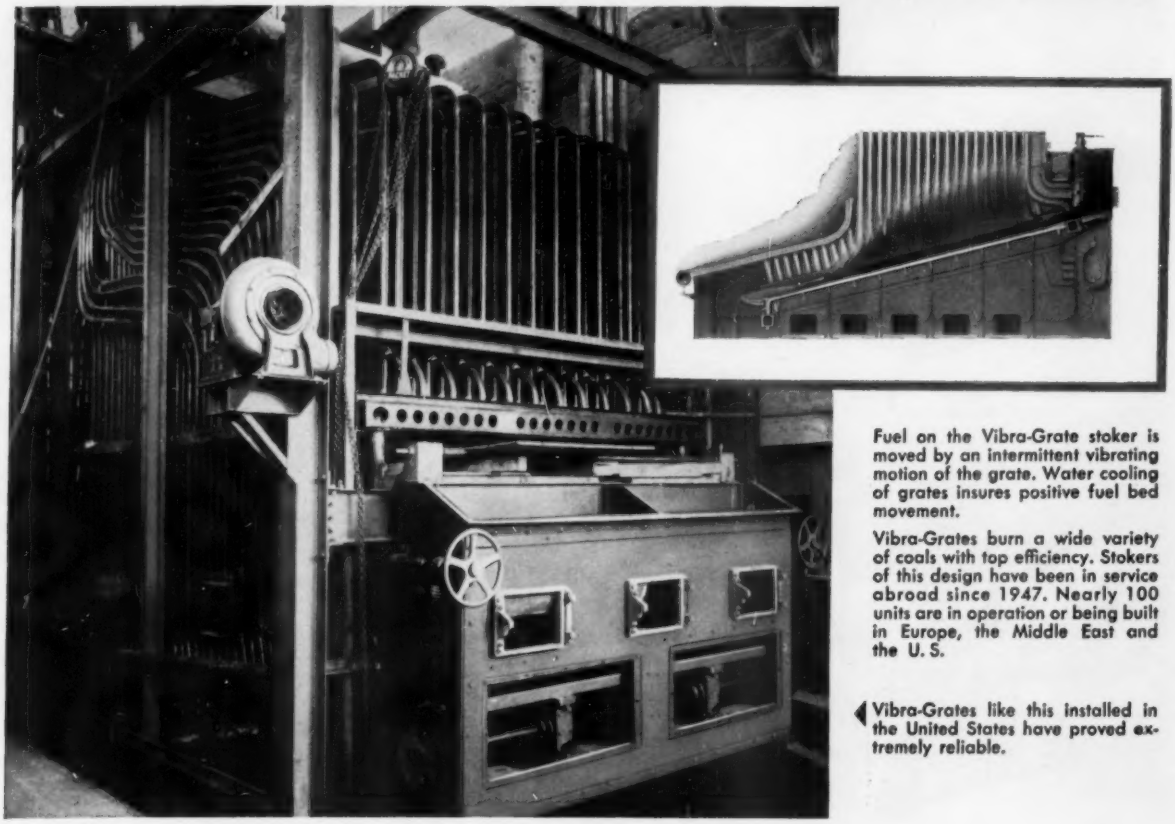

Fuel on the Vibra-Grate stoker is moved by an intermittent vibrating motion of the grate. Water cooling of grates insures positive fuel bed movement.

Vibra-Grates burn a wide variety of coals with top efficiency. Stokers of this design have been in service abroad since 1947. Nearly 100 units are in operation or being built in Europe, the Middle East and the U. S.

◀ Vibra-Grates like this installed in the United States have proved extremely reliable.

WHEN A SOUTHERN STATE required a new stoker installation at one of its institutions, it set up certain basic requirements... great reliability ...abolition of smoke...freedom from objectionable discharge of solids from stack, all while burning local coals. Freedom from fly ash discharge was so essential, in fact, that any form of suspension or semi-suspension burning of coal was eliminated from consideration. AE water-cooled Vibra-Grate stokers were the obvious answer and two of them will be installed... *without dust collectors.*

Each Vibra-Grate stoker will have a steam generating capacity of 30,000# per hour continuously, with 35,000# peaks. The coal to be burned has the following proximate analysis: H_2O, 3%; V.M., 18%; F.C. 67%; ash, 12%; S., 1.5%; BTU per # A.F., 13,400. Other Vibra-Grates in the United States have been burning high volatile coals.

AE Vibra-Grate stokers are available in standard capacity ranges from 25,000 to 150,000# of steam per hour. Write for full information about Vibra-Grate, today's most efficient stoker.

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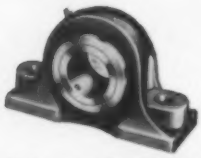

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Turbines for B-F Pumps

continued from page 73

is to establish about 30 per cent of maximum flow through the boiler at pressure above critical, before any fires are lighted. This requires a large high-pressure pump, usually driven by a motor since the power for the pump must be independent of the boiler it serves.

When turbine driven feed pumps are used, the motor driven pump serves for starting and light load feed water supply. In most cases, it is expected that this motor driven pump will eliminate the need for high pressure nozzles in the boiler feed pump turbines.

Since the feed pump power per kw generated increases rapidly as steam pressure increases, the advantages mentioned earlier for turbine driven pumps are particularly apparent in supercritical installations. Supercritical stations are now being designed employing turbine driven feed pumps to obtain the features of variable speed operation and to reduce the size of the electric auxiliary power system.

Continuing progress in central station developments will produce turbine generators of still high capacities and the trend toward higher steam pressures may continue. In such installations, it may prove to be economical to drive other auxiliaries with turbines in addition to the feed pumps. In this case, it may be desirable, perhaps necessary, that some of the turbine drives be condensing.

Conclusions: 1. On the basis of net kw sent out on the transmission line, steam turbine drive for boiler feed pumps results in appreciable economic advantage compared to motor drive, over a wide range of ratings and steam pressure for the main turbine generator (usually for ratings over 150,000 kw and steam pressure over 1800 psig).

2. The principal factor in the favorable economic evaluation is the release of electrical auxiliary power as saleable kw when feed pumps are turbine driven.

3. Although it is a minor part of the favorable evaluation, appreciable gains in heat rate (.1 to .5 per cent) can be obtained in most cases.

4. Other, less tangible, advantages of turbine drive are:

a. Variable speed drive, with possible elimination of feedwater throttling control, and lower design pressures for heaters and piping

b. Direct drive of the pump at speeds above 3600 rpm, which are desirable for recent designs of high pressure pumps

c. Reduction in space required

d. Simplification of piping under the reheat turbine, when non-condensing extraction pump turbines are used

e. Auxiliary electrical power systems are simplified in many cases by elimination of the largest motor in the plant

5. Increased use of supercritical pressure and increase in kw rating of turbine generators will make application of turbine driven pumps even more favorable.

REFERENCES

[1] Economic Comparison of Steam Turbine vs. Motor Driven Boiler Feed Pumps, by A. G. Mellor, R. C. Muir, J. F. O'Mara, and J. F. Ransom, General Electric Company, AIEE Paper No. 56–146, presented at the AIEE Winter General Meeting, New York, January 30–February 3, 1956

[2] Application of Single Turbine Driven Feed Pumps to 225,000 KW Generating Units, by J. A. Tillinghast, American Gas and Electric Service Corporation, presented at American Power Conference, Chicago, March 21–23, 1956. Published in Proceedings of American Power Conference, 1956.

[3] Economics of Turbine Drives for Boiler Feed Pumps, by A. G. Mellor, J. F. Ransom, and E. L. Pace, General Electric Company, presented at American Power Conference, Chicago, March 21–23, 1956. Published in Proceedings of American Power Conference, 1956

1956 Power Show

continued from page 89

motor drives, but in supplementary applications in factory and field. There will be displays of cable testers, dielectric testing and cable fault locating equipment, a-c-d-c converters, frequency changers and testing equipment, variable-speed drives, diesel generating sets, and others. Newest equipment for over-potential testing will be exhibited.

New addition to a line of power equipment will be a frequency monitor for opening or closing an electrical contact when the frequency in a power line reaches a present limit, thus signalling for the proper corrective steps to bring the system back to normal. The new unit is also designed to be used as a low/high frequency alarm for generators, and — in conjunction with an electric tachometer generator — as an overspeed alarm and limiter for turbines.

Thickness gage, of fountain-pen proportions, to measure the thickness of non-magnetic coatings on cast iron and low-alloy steels, will be shown.

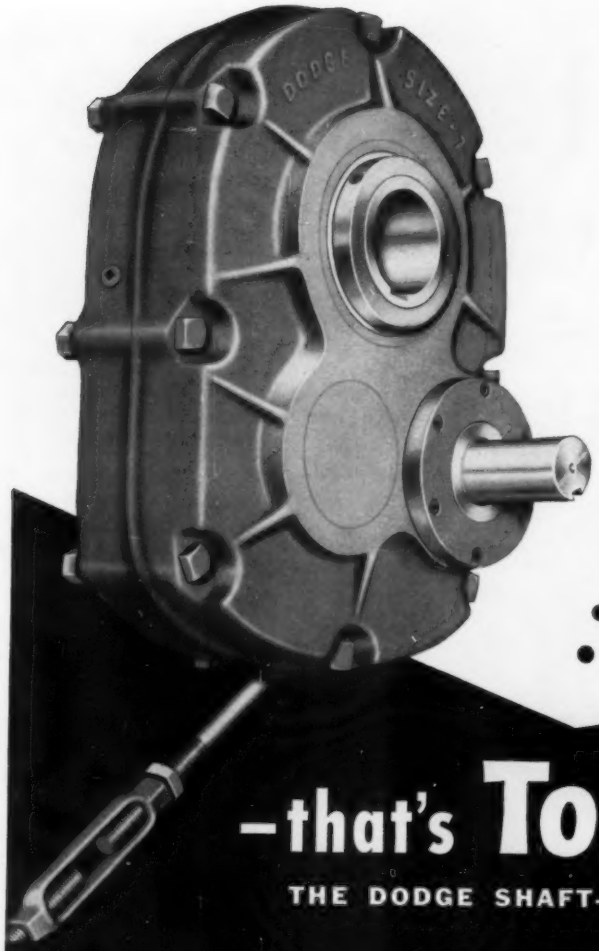
Electrically-powered equipment for efficient automation will be offered in a compact, variable-speed drive having wide range and fine regulation. At the same display will be shown a motor-generator set with a-c and d-c controls, mounted in a pressurized, self-ventilating steel cabinet.

New Materials

In the field of materials there will be, among other exhibits, new varieties in clad steels and many new special purpose alloys, self-lubricating bearings and powder metal parts, metalizing equipment, metal cutting tools, spring coilers and torque testers, welding rods and equipment, protective coatings.

Manufacturer of centrifugal castings will exhibit for the first time ductile iron and ductile alloys in centrifugal cast form.

Another exhibitor will reveal improvements in the solidity and con-



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1956 Power Show

continued from page 120

centricity of condenser tubes, effected through the application of Magnaflux testing. Condenser tube manufacture will be demonstrated.

New line of duct is composed of fiberglass impregnated with neoprene or silicone, and reinforced with wire. It is designed to withstand temperatures from − 65 to + 600 F and is produced in a range of 1 in. to 12 in. I D.

New expansion joint has been designed to eliminate use of thin-wall corrugated bellows in piping systems, to accommodate traverse expansion and misalignment, and to resist damage where piping is subject to vibration and shock.

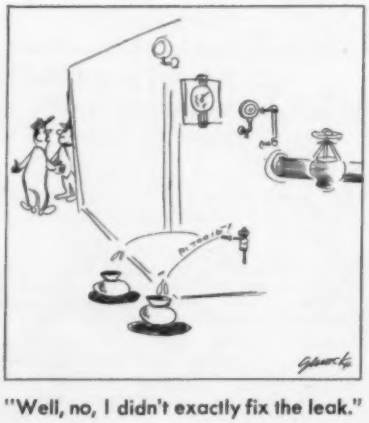
First hydraulic bolt tensioner, providing the fastest method for securing uniform pressure control on gaskets, will also be exhibited.

Water Saving

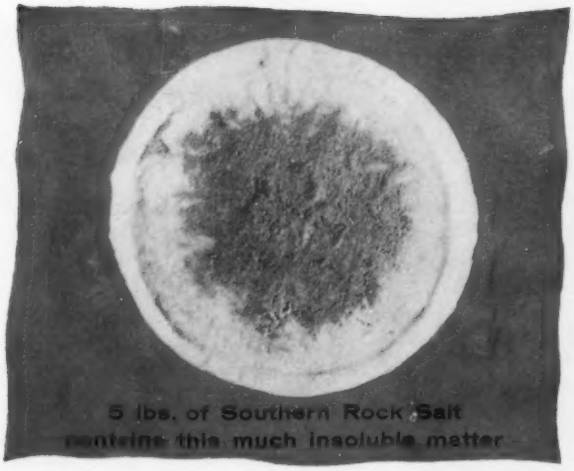
Water saving in industrial cooling, with temperature controlled to within 2 deg F, is offered in a new heat exchanger, an evaporation apparatus designed to maintain required thermal level by the modulated use of outdoor air. The system is available in four capacities — 7,000,000 to 18,000,000 Btu per hr — and is designed for convenient outdoor ground or roof location adjacent to the point of distribution.

One of the most novel displays at the exposition will be the industrial tractor that threads the aisles of an industrial plant with several trailer loads of material in tow, without an operator at the steering wheel. Control of the train is by electronic signals, communicated to a receiver on the tractor from a guidance wire, which may be embedded in the floor, laid on the floor under a protective tape, or strung overhead.

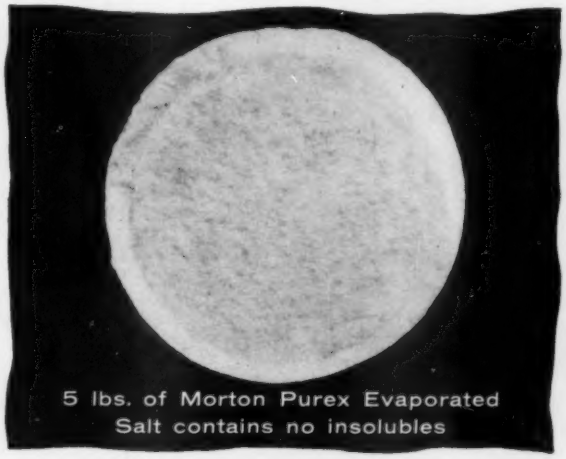
The 1956 Power Show is under the management of International Exposition Company, 480 Lexington Ave., New York 17, N. Y., E. K. Stevens, manager.



"Well, no, I didn't exactly fix the leak."



All filter pads shown, approximately ⅓ actual size. Tests for insolubles were taken from random samples.



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When you buy Morton Purex Salt, you get high purity evaporated salt that is made in a controlled-particle size to prevent packing and channeling. None of your freight bill or purchase price goes toward paying for shale and sulphates . . . insolubles like those shown on three of the filter pads above. (And the cost can be considerable. In every 100 lbs. of any of the types of rock salt shown above, you are paying for up to 5 lbs. of insolubles.)

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NEW ENGINEERING BOOKS

Electric Power Stations, Fourth Edition Revised and enlarged, Vol. II, by P. H. Carr. Cloth binding, 832 pages including index. 6 by 9 in. Published by Chapman and Hall, Ltd., 37 Essex St., London, England. Price, 80 shillings ($11.28).

This is a basic engineering book covering both the prime mover and electrical end of generating plants. The subjects covered include feedwater heating, water treatment, steam condensation, alternators, transformers, end reactors, switch gear, fire fighting and air raid precautions, costs, hydro, diesel, gas turbine, wind and atomic power plants. The book gives a great deal of attention to those "insignificant" factors which can waste much time for the engineer who is looking for answers. It would seem equally valuable to those designing and operating power stations, no matter what the prime mover.

★ ★ ★

Reflections of a Physicist by P. W. Bridgman. First Edition, 5¾ by 8¾ in., 576 pages, cloth. Philosophical Library, Inc., 15 East 40th St., New York, N. Y., 1955. Price $6.00.

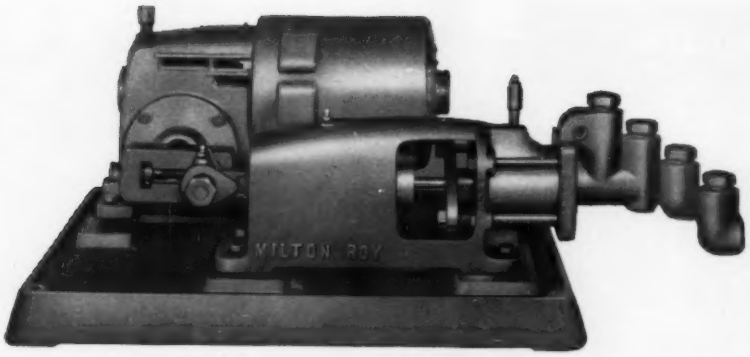
This selection comprises the bulk of the non-technical writings of Dr. Bridgman, together with three papers which are published here for the first time. The topics range over a considerable field, but there is a certain unity in the treatment, in that the "operational" approach is used throughout. It is this approach which has made possible the successes of modern physics in meeting revolutionary new physical situations. The present collection may be regarded as an extension of the operational approach to problems in other fields than physics.

★ ★ ★

Butt-Welding Ends for Pipe, Valves, Flanges and Fittings. Published by the American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y. Pamphlet with no cover, 10 pages, 8½ by 11 in. Price $1.00.

This is the new American standard ASA-B16.25—1955. This standard covers the preparation of butt-welding ends for pipe, valves, flanges and pipe fittings. It is equally applicable, however, to other piping components which are connected to the piping system by butt welding.

It includes requirements for re-entrant shapes for heavy wall ends, welding beveled profiles, inside contours for joints made with or without backing rings, and machining dimensions with their tolerances. This is new information, and very essential in the new construction or maintenance of piping systems.



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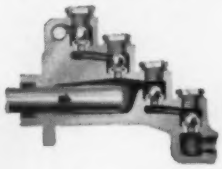

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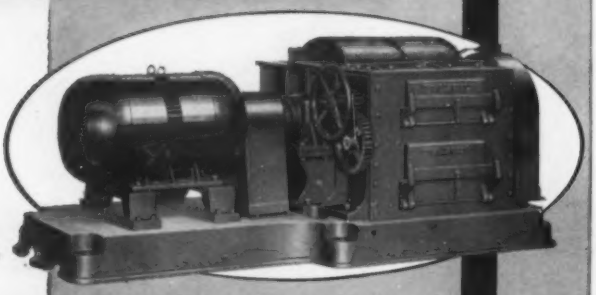

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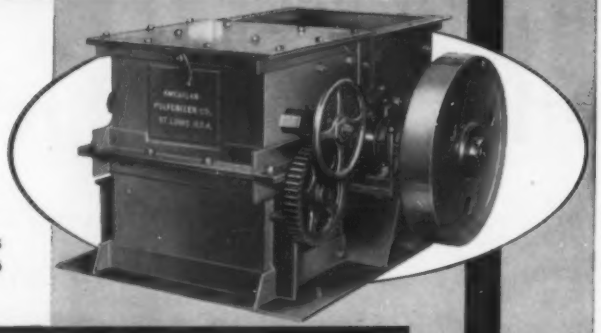

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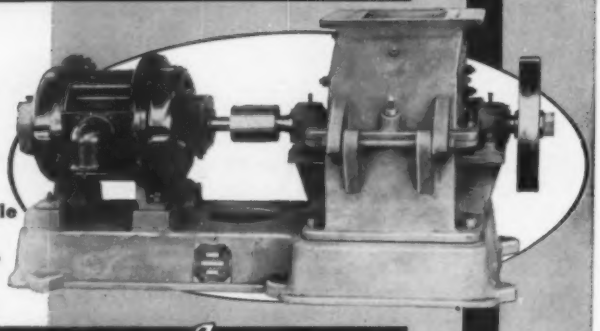

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Engineering Books

continued from page 124

The Cooling of Electrical Machines and Cables, by Theodore de Koning. First Edition, 6 by 9 in., 233 pages, cloth. Zuid-Nederlandsche Drukkerij, 'S-Hertogenbosh, Holland, 1955. Price $5.00 to individuals, $15.00 to Electrical Manufacturers.

Some six or seven years ago, the editor of POWER ENGINEERING became interested in a radically new and unconventional method of cooling large electric generators proposed by Theodore de Koning, the author of this book. This method involved what he called "Vaporization Cooling." In this method, water is supplied in the form of a mist to the natural surfaces bordering the air gaps of rotating electrical machines. The gap and the space surrounding the end windings are kept under vacuum. Compared with air cooling, the heat transfer coefficient is at least 50 times as great.

The obvious advantages of this method of cooling were intriguing, but the method was so revolutionary that the author met with very little encouragement in his attempts to interest the large American manufacturers of electric generators in his proposals. He presented two papers on the subject before the American Institute of Electrical Engineers in 1950, and while these papers attracted much attention, at the same time they failed to stimulate action by any of the large manufacturers.

As Mr. DeKoning points out in the preface to his book, the inertia of the human mind and the dictates of self-interest are dominant. Furthermore, the large research and development organizations of the major manufacturers resent outsiders trespassing in their particular spheres and interfering with their well-planned development programs.

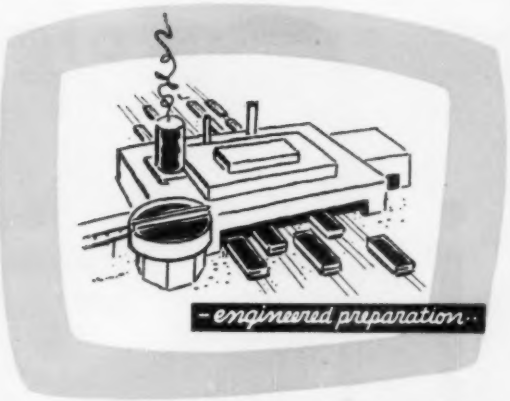
As a consulting engineer, however, the author did succeed to some extent in bringing his ideas to the engineering profession and the U. S. Navy consulted him on the cooling of certain types of electrical machines.

In October, 1952, POWER ENGINEERING published his article entitled: "Light Weight Generator Cooling."

This book is a record of the author's work and ideas. It consists essentially of the substance of eight papers which he wrote: those presented before the AIEE and others. Though the papers were written as independent units, they form a whole as the central thought in all cases is the same. This thought is to make full use of the new possibilities created in the design of electrical machines and cables.

Chapter 1 deals with the vaporization cooling of large electric machines and covers both the cooling of the stator and rotor as a unit. Chapter 2 on "Light Weight Turbo Generator Rotors" deals with the cooling of the rotor only. Chapter 3, "Stator Windings and Generator Leads," deals with the cooling of the stator windings and their con-

"by land and by sea"



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Engineering Books

continued from page 126

nections. These three papers form one unit as they deal with different aspects of the cooling of large electric machines.

Chapter 4 "Monocast Electric Rotors and Stators" deals with the cooling of A-C motors. Chapter 5 "Cooling Large Commutator Machines," deals with the cooling of the commutator and the rotor of d-c and variable speed a-c machines. Chapter 6 is devoted to skin-cooled electric ship propulsion motors. Chapter 7 entitled: "Steel Plant Electric Rolling Mill Drives, etc.," deals with the cooling and reduction of the heat losses of motors employed in such drives. The final chapter, Chapter 8, deals with low specific gravity transmission cables, that is, the cooling of paper insulated high-voltage cables.

Anyone interested in or practically concerned with the cooling of electrical machinery, will find this book stimulating and refreshing. It opens up new opportunities for making electric machines more compact, longer lived, and more efficient.

Readers may wonder at the difference in price of this book. One price for individuals another for manufacturers. The reason for this is that the author could not induce technical book publishers to publish this book, so he was compelled to publish it himself. Not being bound by customary methods of marketing and standard price, he thought out this method of letting manufacturers, individuals and libraries each pay a fair price for the book.

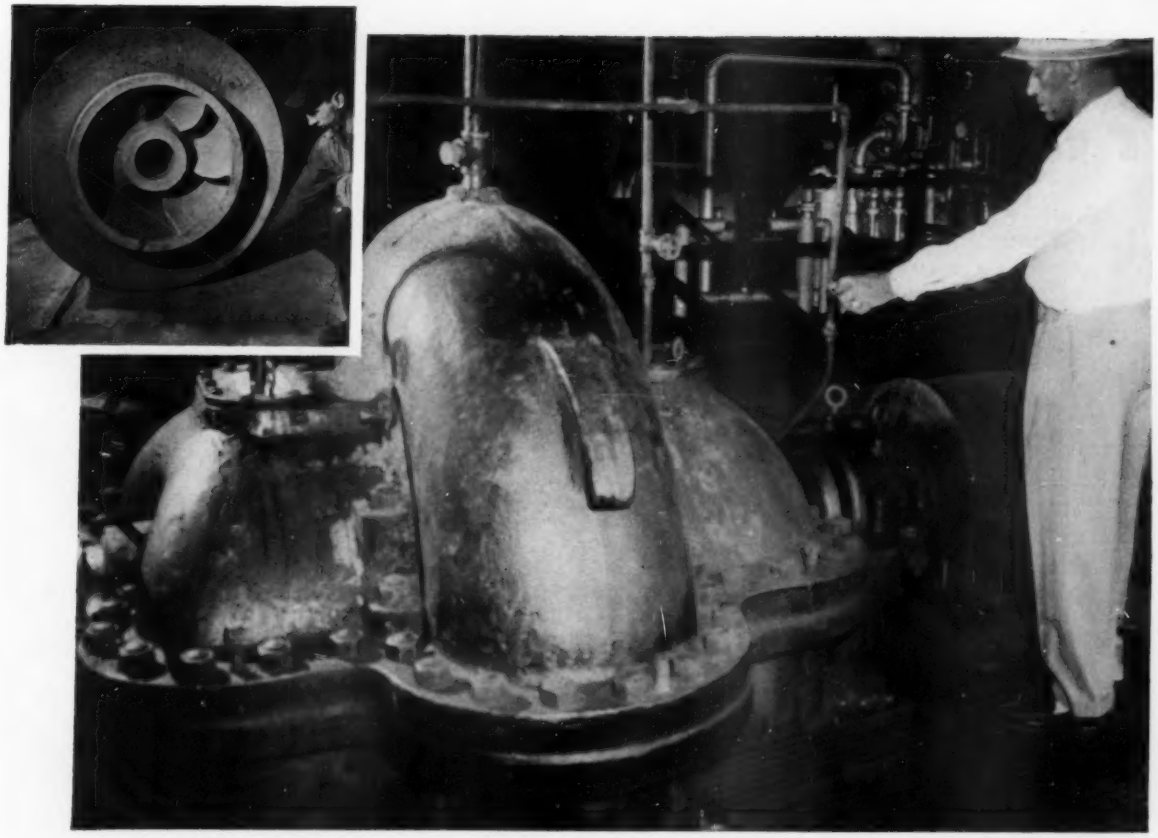
As a result, there are two editions, one a red-covered edition which can only be purchased by manufacturers of electrical machines or cables which sells for $15.00, and another, a blue-covered book for other readers which sells at $5.00. The blue-covered book is not permitted on the premises of electric manufacturers.

★ ★ ★

Electro-magnetic Machines by R. Langlois-Berthelot. First English Edition, 6 by 9 in., 535 pages, cloth. Philosophical Library, Inc., 15 East 40th St., New York, N. Y., 1955. Price $15.00.

This book was first published in France. It has been translated and revised in collaboration with Lieut. Colonel R. M. Clarke. The author is the Director of one of the most modern and best equipped high voltage laboratories in Europe. He has also had experience as a manufacturer of electrical plant equipment.

The book, which is divided into six parts, deals with questions common to the different classes of electro-magnetic machines that term covering transformers and rotating machines. It relates the various kinds of electrical machines to each other, recognizing them as being of one family, having a common basis of existence. Fundamental principles that remain, rather than practice



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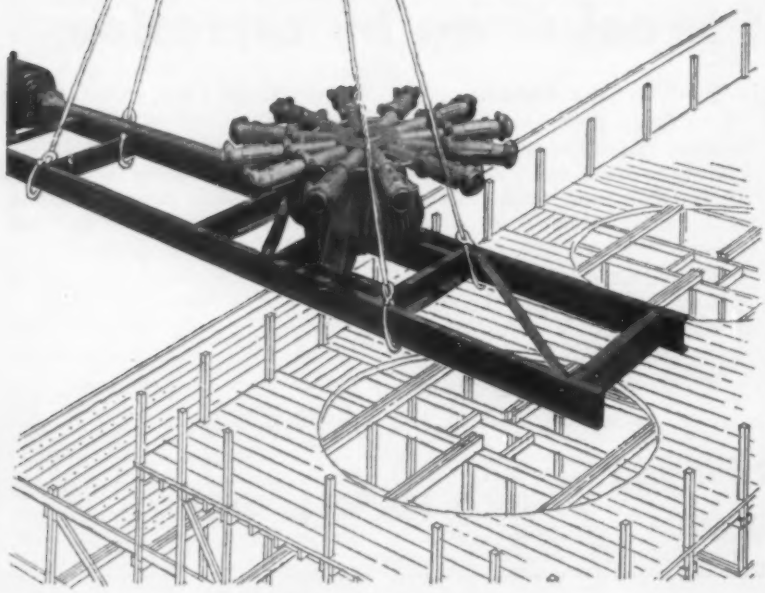

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Engineering Books

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that frequently changes, are in the text of this book firmly established.

It might be asked why a book such as this should be produced when there are already so many American and English textbooks, excellent in their own way, which purport to convey the same message. In a foreword by C. W. Marshall of the British Electricity Authority, this question is answered. He says that this book is unique in its respect of objectivity in excluding as far as is practicable everything that is transitory, and in retaining what appears to be permanent. It is thus a happy mean between the classified French treatise, which tends to exclude everything that savours of practice, and the materialistic English, which concentrates on which is for the time being practical and utilitarian.

★ ★ ★

Hydraulic Turbine and Draft Tube Settings, Publication No. 55-9. Pamphlet with no binding, 13 pages, 8½ by 11 in. Published by the Edison Electric Institute, 420 Lexington Ave., N. Y. 17, N. Y. Price 40 cents to members and their employees, $1.00 to non-members in the U. S. A., or $1.10 to foreign countries.

This is a short but useful report of the hydraulic power committee of the Edison Electric Institute. It is a review of present practice on the settings of reaction- and propeller-type runners with respect to tail water level and the influence of these draft tubes on the efficiency and economy of hydraulic turbine installations.

The underlying principles and functions of the various types of draft tubes here described and the influence of specific speed and cavitation factors on design and operation are discussed. In order to analyze the problem in its entirety just before it summarizes the various factors involved from a practical operating standpoint, it seems to be a worthwhile addition to the technology of hydraulic turbines and related subjects.

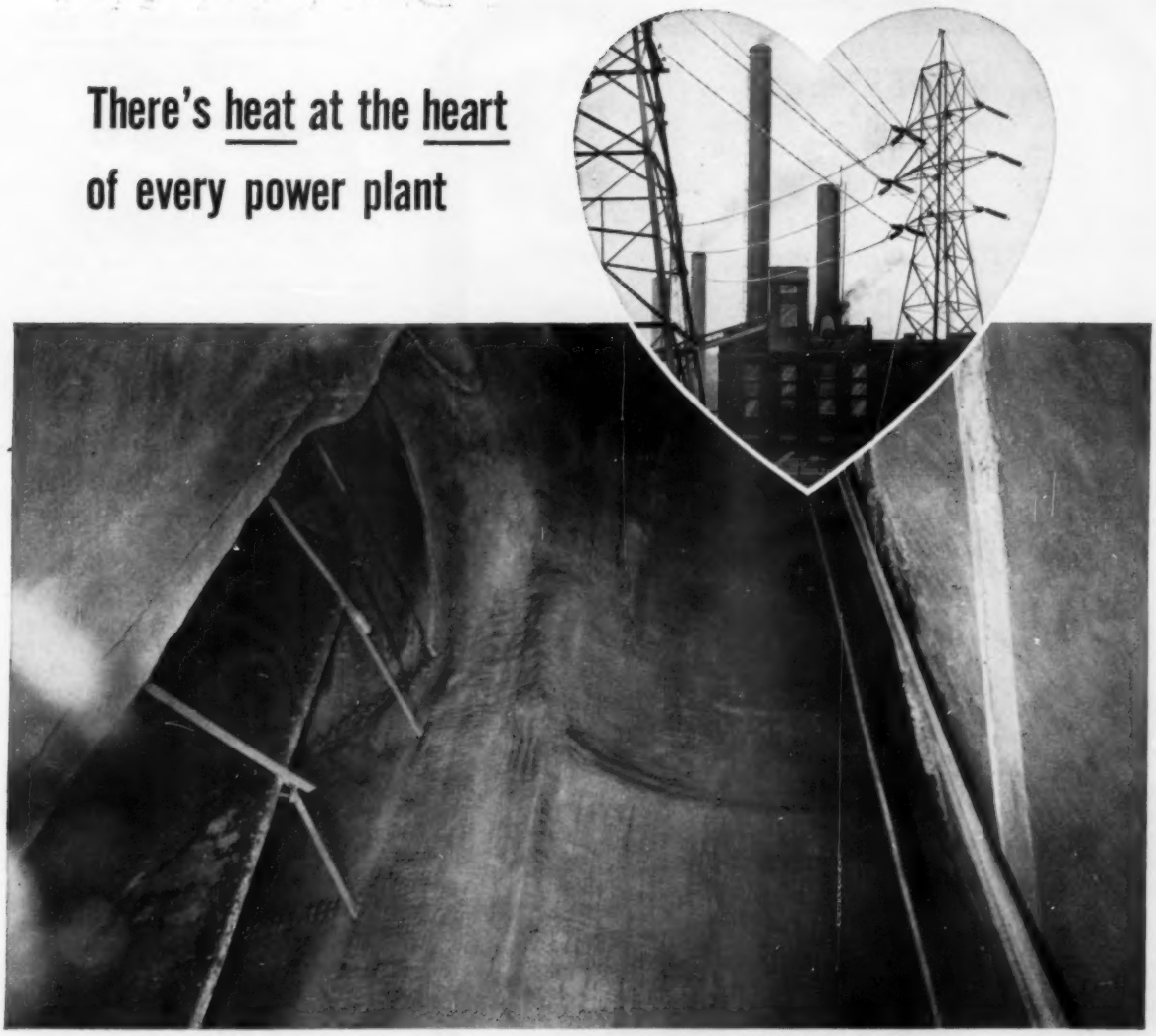
★ ★ ★

Nuclear Energy and Its Uses in Peace by Gerald Wendt. First Edition, 5¼ by 8¼ in. 78 pages, paper covered. Published by the Columbia University Press, 2960 Broadway, New York, N. Y., 1955. Price 50¢.

This little book is published as part of the program and work of the United Nations Educational Scientific and Cultural Organization. It describes simply and clearly the impact and significance of nuclear energy upon the world. Beginning with an introduction discussing the various types of energy available in the world, it goes on to the principles involved in the energy released from nuclear fuels, discusses sources of raw material, reactors, and the relation of reactors to the production of power.

There is a very good chapter on radioactivity and another on the use of radio-

There's heat at the heart of every power plant



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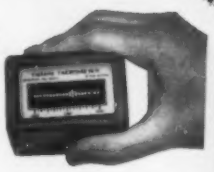

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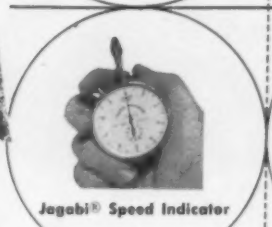
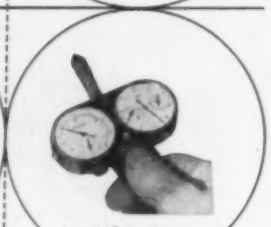


Jagabi® Speed Indicator



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Engineering Books

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active tracers in industry in agriculture and in biological research. Finally, in the last chapter there is a discussion of the future of this new science, its international prospects, the United Nation's action, and its influence on the food and agricultural resources of the world. It is a very good little book for anyone who wants an all-around discussion of nuclear energy.

★ ★ ★

Gas Turbines and Jet Propulsion, Sixth Edition by G. Jeoffrey Smith. Cloth binding, 412 pages, 6 by 9 in. Published by Philosophical Library, 15 E. 40th St., New York 16, N. Y. Price, $15.00.

Though the greater part of this book is devoted to jet propulsion, there is much to be learned about the important components of all gas turbines from their studies of compressors, combustion chambers and turbine wheels. As usual, the book starts with a review of prehistoric gas turbines, but quickly it comes up to more current events. Stationary gas turbines are finally treated in the last chapter entitled "Other Turbine Applications."

The treatment is, of necessity, rather cursory because of the limited number of pages reserved for stationary plants. Considerably more detail is given on current experiments with turbines for road vehicles. The book is well written, though of limited use to engineers working in the stationary power field.

★ ★ ★

Interior Electric Wiring and Estimating, Part II, Industrial by Kennard C. Graham. Cloth binding, 325 pages, 8½ by 5½ in. Published by American Technical Society, 848 E. 58th St., Chicago 37, Ill. Price $4.95.

This book explains how to plan and install industrial lighting and power systems. It covers the subject very comprehensively, and collects into one volume all the details that usually receive only incidental treatment in engineering textbooks.

To give an idea of the scope of the book, here are summaries of its eight chapters.

1. Industrial Methods: This chapter describes the most common methods of wiring in present-day industrial practice. It describes methods of installing conduit and cable, underfloor ducting, busways, raceways, wireways, trolley-type duct systems, and other methods of distribution in common use.

2. Planning Industrial Lighting: This chapter gives a brief summary of lighting theory, compares different types of lighting, gives the characteristics of available light sources, and shows how to go about planning lighting systems for various types of industrial building in order to obtain a required standard of illumination.

3. Installing Industrial Lighting: Gives

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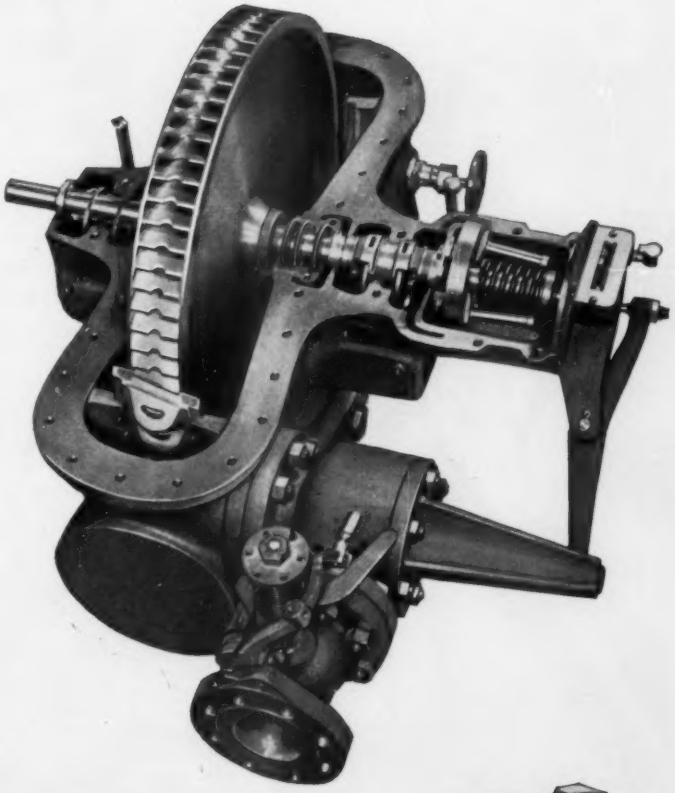

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continued from page 132

practical information on installing lighting systems, including fixture hanging, panelboard installation and connecting, figuring branch circuit capacities, number and size of conductors to be used, and all other details needed to complete an industrial lighting installation. Application of the National Electric Code is explained in this chapter and throughout the book.

4. Wiring for Motors: This chapter explains briefly the principles governing motor control and then describes the various methods of starting and controling motors in common use today. As with the other chapters in this book, the application of the National Electric Code is carefully explained to show how it is applied in the planning and installation of motors and control systems. This chapter shows how to calculate wiring sizes for various motors, and gives wiring diagrams to show how the most common types of motor and starters are installed.

5. Generators, Power Feeders, and Services: Gives practical details for installing this type of equipment.

6. Transformers, Capacitors, Industrial Power Distribution: Explains application of this equipment to industrial power systems and describes the main types of system in use today.

7. Special Circuits and Applications: This chapter covers the application and installation of such items as X-ray equipment, infra-red lamps, induction heating equipment, electric welders, signs and outline lighting, remote control, low energy and signal circuits, etc.

8. Estimated Electrical Wiring: the final chapter presents a complete electrical estimate, based upon drawings and specifications which have been made a part of the text. The method is explained in a step-by-step process, and is carried out to the final figure which is presented to the customer. The procedures explained may be easily varied according to the size and nature of a particular job, or the personal inclinations of the individual estimator.

CATALOG LIBRARY

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ELECTRICAL EQUIPMENT

201 **Industrial Systems** — Bulletin GED-3039, 48 pp, gives information on distribution system planning. Features, advantages, application, operation and other data on system-engineered equipment for industrial power distribution, including switchgear, unit substations, switchboards, transformers, busways, wire and cable, conduit products, voltage regulators, capacitors, circuit breakers, safety switches, panelboards, controls, motor controls, motors, turbines, rectifiers, and wiring devices are covered. Photos are included. General Electric Co.

202 **Testing Instruments** — Bulletin 19–56, 16-pp, features company's electrical testing instruments, including ohmmeters, ground testers, dielectric test sets, motor rotation tester, cable fault locating equipment, transformer turn ratio test sets, corona test equipment, frequency meters, tachometers, others. Includes photos and descriptions of each type, including chief features, operating ranges, and applications. James G. Biddle Co.

203 **On Copper Conductors** — Publication C-25, 62 pp, is designed to help make the selection of bus conductors easier. Included in booklet are tables regarding such shapes as channels, ventilated square tubes and round tubes. There are tables for other rigid bus conductor shapes, also data on bare copper wire and cable as well as commonly used alloy wires. Also provided is a general discussion of copper, its physical and electrical properties. Photos illustrate many installations. The American Brass Co.

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204 **High Capacity Fuses** — Form HC8, 6 pp, describes fuses of unlimited interrupting capacity on voltages to 600, designed to afford protection for loads of 600 to 5000 amp. Includes test data, charts on opening time, current limiting effect. Bussmann Mfg. Co.

INSTRUMENTS AND CONTROLS

206 **Metering and Control Equipment** — Sixteen-pp Bulletin 18 is a comprehensive catalog offering information on company's meters, control equipment and engineering services. It is written for engineers in power plants, public utilities and process plants. Fifteen measured variables common to power and process operations form the index for selecting appropriate equipment. Bailey Meter Co.

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207 **Boiler Feed Control** — Bulletin 1003, a 12-pp catalog on boiler feed regulators, is illustrated with large application photos and detailed schematic drawings and charts. Relay and direct operation are covered. Case studies of representative boiler loads are presented to show stability of the Flowmatics in controlling feedwater. Copes-Vulcan Div., Blaw-Knox Co.

208 **Instruments, Controls** — Condensed Catalog 1537 offers brief application information on manufacturer's line of instruments. Fully illustrated, covers draft and pressure instruments, flow meters, liquid levels and pressure gages, CO_2 meters, pneumatic transmitters, positioning operators, temperature instruments, boiler feedwater controls, others. Includes references to detailed literature on each type of equipment. Republic Flow Meters Co.

209 **Indicating Flow Meter** — Bulletin 18-A, 22-pp, discusses advantages, construction and operation of company's Type H indicating flow meter. Presents technical data on the principles and theory of fluid measurement and discusses orifice type meters and orifice meter principles. Offers examples of flow rate calculations. Schematic drawings and diagrams, tabulated technical data and specifications are included. The Meriam Instrument Co.

210 **Solenoid Pilots** — Several types of solenoid pilots for use with company's regulating valves are described in Form 1010. Lists reasons for economies in on-off control, describes applications, and gives type of pilot, material of construction, maximum pressure and maximum temperature for two- and three-way pilots in steam, air, gas and liquid service. Schematic diagrams of typical applications are given. Spence Engineering Co., Inc.

211 **Easy Reading Gage** — An all-hydrostatic remote reading gage for boiler water and other liquid levels is described in Catalog 500, Section CO. Pictures improved visibility, other advantages offered by this gage, explains operation. The Reliance Gauge Column Co.

212 **D-C Amplifier** — Twelve-pp Bulletin MSP 111.1 provides pictorial diagrams and descriptive information on company's PowrAmp Model P, an electronic low-voltage linear amplifier designed to increase the speed and accuracy of low level d-c voltage measurements. Discusses performance and construction features of the amplifier, and describes some applications. Hagan Corp.

213 **Resistance Temperature Detectors** — In 8-pp Publication 3016D are described a line of remote temperature-sensitive elements for use in indicating, recording, controlling and monitoring equipment. Operation, application and construction details of the resistance temperature detectors are presented, along with specifications and ordering tips. Instrument Div., Thomas A. Edison, Inc.

214 **Ideas on Push-Pull Controls** — Included in this "Idea File" are answers to a power engineer's questions on the use of push-pull controls. A general information booklet discusses remote control applications, explains construction and operation of company's Tru-Lay controls. Separate bulletins are devoted to standard assemblies, bracket-type head controls, micro controls and hand-operated controls. Automotive and Aircraft Div., American Chain & Cable Co., Inc.

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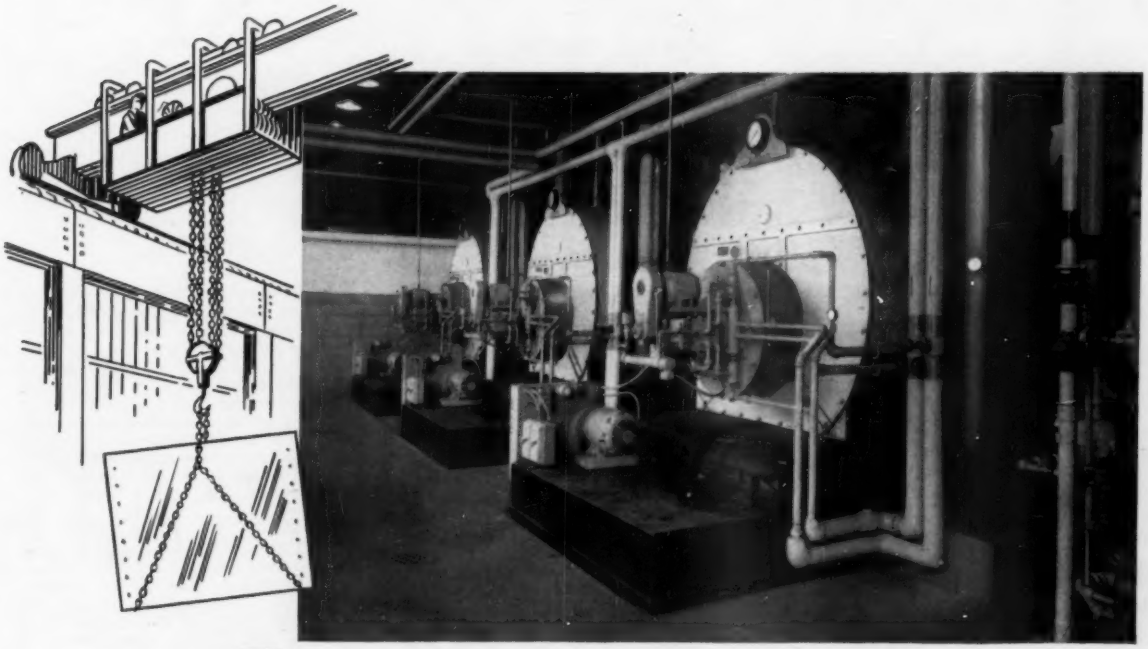

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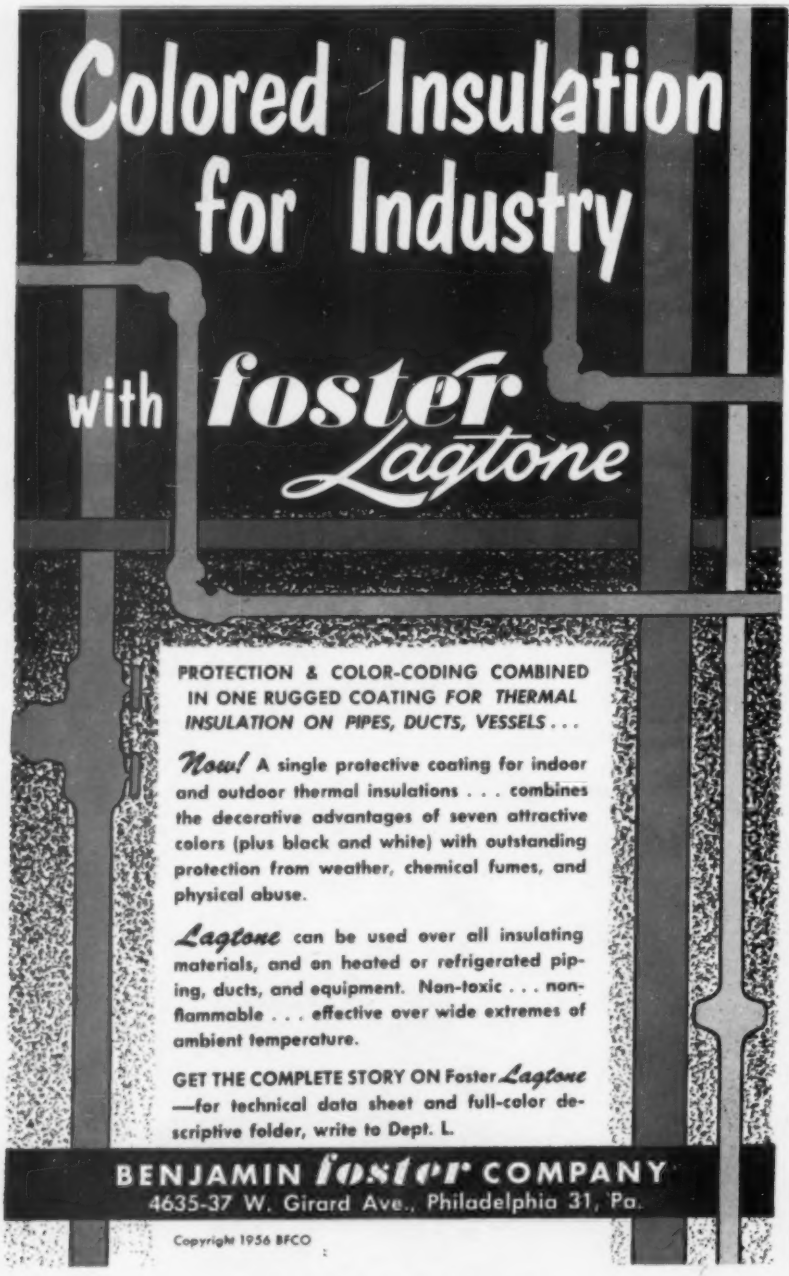
215 Bi-Color Gage — Bulletin 1174 gives advantages of company's Multi-Port bi-color gage made for boiler operating pressures to 3000 psi. Points out chief design features, illustrates construction details through photos and drawings. Diamond Power Specialty Corp.

216 Oil Leak Detection — Eight-pp illustrated Bulletin 80, on the Paraprobe oil leak detection system for steam-type fuel oil heaters gives a detailed explanation of the operation of the system. Provides installation diagrams, standard specifications, explains determination of condensate flow rate. Davis Engineering Corp.

217 Sampling System — A newly developed system for continuous sampling and oxygen measurement of combustion processes is described in Bulletin 703. Points out advantages of system and diagrams component parts. Selection of sampling tube and gas selector units is discussed. Arnold O. Beckman, Inc.

BOILERS, GENERATORS

218 Packaged Boilers — This 16-pp illustrated catalog describes manufacturer's new Type VP package boiler. Following a section of background information is an outline of the principal design features of these boilers, which are shop assembled and provide steam capacities from 4000 to 40,000 lb per hour. Space requirements are shown in a table with specifications. Combustion Engineering, Inc.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219 Steam Generators — Illustrated Bulletin SB43, 20 pp, describes company's VL factory assembled generators combining 2-drum water-type boiler, integral water cooled furnace, brick work, insulation and steel casing. A large cutaway illustration shows design details, and gas travel. Erie City Iron Works.

220 Improved Steam Generator — Bulletin 2000, 28 pp, explains advance design features that distinguish this manufacturer's generator from other unit steam generators. Describes and illustrates engineering differences of component features. Also shows how these components are constructed, assembled and tested. Another section gives data, and dimensions for the units which range from 20 to 6000 hp. Preferred Utilities Mfg. Corp.

221 Steam Generators — Bulletin 55-1, 22-pp, describes company's products and services, including not only steam generators but also custom metal fabrication. There are many photos of boilers in various stages of assembly. Engineering drawings of boilers producing up to 500,000 lb of steam per hr on standard fuels are included, as well as illustrations of units for waste heat application and those designed to utilize refuse for fuels — wood chips, coffee grounds. The Wickes Boiler Co.

222 Boiler Family — Bulletin B-3300-A describes a wide range of company's heating and power boilers and includes photos and cutaway views showing construction features. A list of bulletins on the various types of boilers is included. Titusville Iron Works Div., Struthers Wells Corp.

223 Water Tube Boilers — This 12-pp catalog describes packaged water tube boilers, capacities to from 8000 to 50,000 lb per hour. Interesting as well as informative, this booklet uses color and illustrations to amplify text. Gives complete data and dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

224 Packaged Generators — Bulletin MH 3-54, 14-pp, gives detailed coverage to company's Type MH packaged water tube steam generators which are furnished for oil or gas firing or both, with automatic, semi-automatic, or manual controls. Included are: cutaway illustrations, installation photos, tube arrangement layouts, construction details, auxiliary equipment, dimensions. Union Iron Works.

225 Shop-Assembled Boiler — Sixteen-pp Bulletin G-76 completely describes and illustrates company's Type FM water-tube integral-furnace boiler, made in standard sizes from 2900 to 28,000 lb of steam per hr, pressure to 250 psi. The Babcock & Wilcox Co.

226 Packaged Generators — This 16-pp catalog covers a new series of packaged steam generators in sizes from 10,000 to 46,000 lb of steam per hour. Gives capacities, dimensions, construction features. Instrumentation is discussed. Illustrations include sectional drawings and installation photos. Booklet also provides a selection chart covering firing equipment and controls. Foster Wheeler Corp.

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227 V-S Drive Selection Tips — Bulletin 20P50, 44 pp, carries handy

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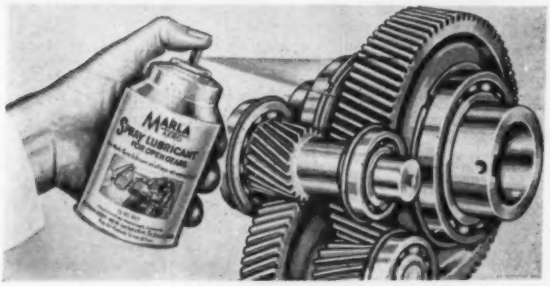

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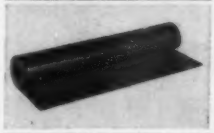

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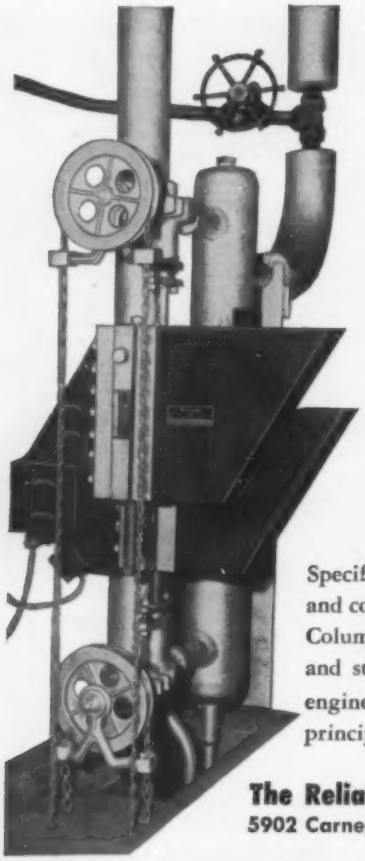

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multi-color tables for quick and easy selection of variable speed Texrope drives. In addition to providing these tables for A, B, C and D section variable speed drives, booklet includes information on design features, drive principles, horsepower rating tables, speed range table. Allis-Chalmers Mfg. Co.

228 Fluid Drives — Bulletins 9419 and 9519 are an illustrated catalog and selection guide on company's new Type VS Class 2 Gyrol fluid drives. Catalog discusses advantages and applications of the drives, covering speed control, power savings, simplified installation, etc. A sectional view shows construction and principle of operation. Dimensions for six sizes of drives are provided. Selection guide consists of tables indicating proper drive to use. American Blower Corp.

229 Speed Reducers — Design and operation advantages of company's line of Torque-Arm speed reducers are outlined in 28-pp Bulletin A-637. Includes selection tables for double and single reduction units, bore dimensions and bushings, data on overload releases, flange mounted speed reducers, and recommended V-belt drives. Dodge Mfg. Corp.

VALVES, TRAPS, PIPING AND ACCESSORIES

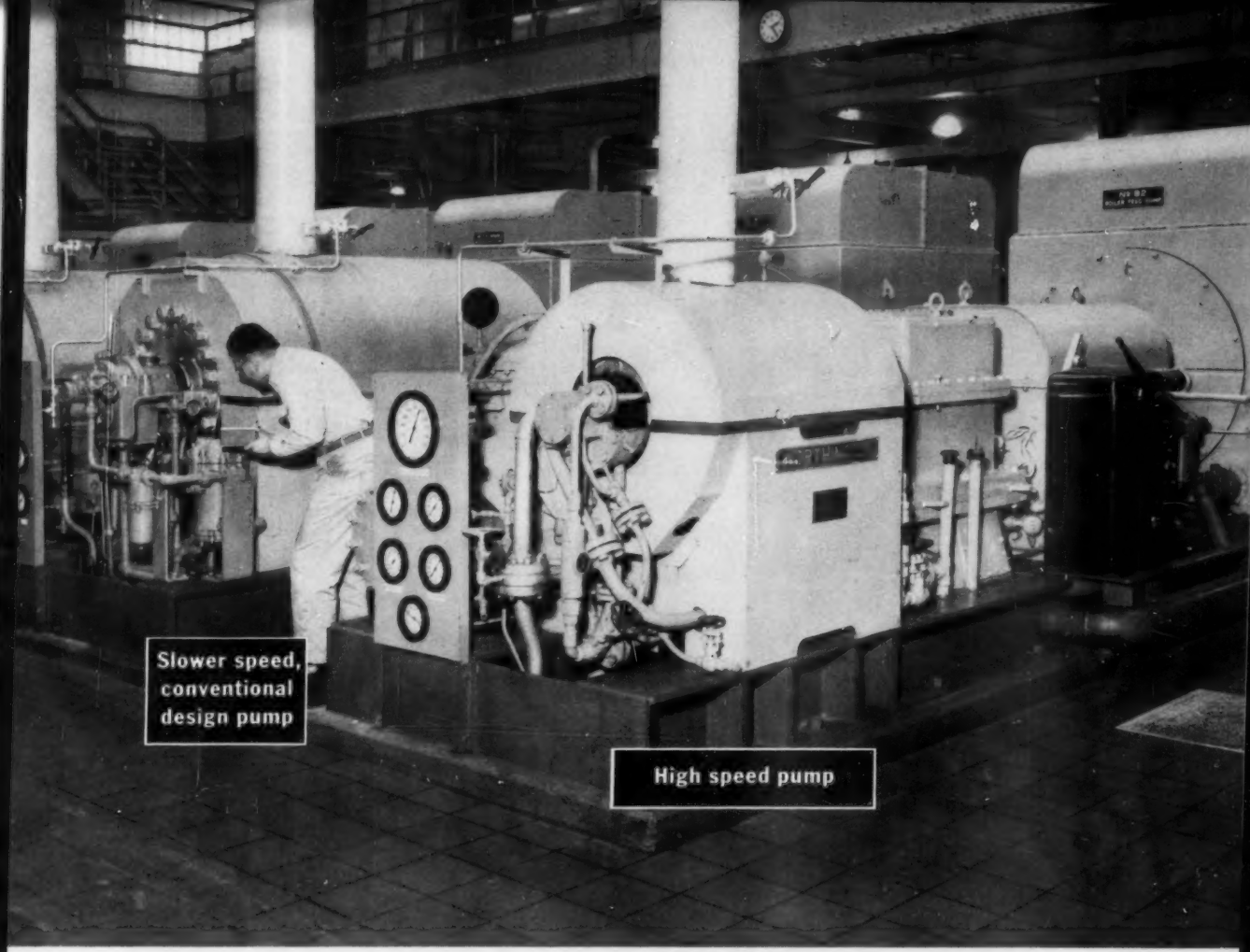
230 Check Valves — Twenty-pp Catalog 30 presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 3000 psi. Explains operating principles of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

231 Lubricated Plug Valves — Catalog PV-24, 36-pp, shows in detail a line of iron and steel lubricated plug valves. Many illustrations of the single, screwed and bolted gland type valves are shown, including photos, sectional and detailed drawings. Also included is physical data on dimensions. The Wm. Powell Co.

232 General Purpose Valves — Supplement No. 1 to Catalog F-9, 32-pp, offers complete information on company's series of general purpose drop forged steel valves, gate, globe and angle types, sizes ¼ through 2 in. Includes descriptions of each type along with drawings showing component parts. Dimensions and other specifications are tabulated, and a pressure-temperature ratings table is included. Henry Vogt Machine Co.

233 Valve Charts — Now available to power engineers are three well-organized wall charts on valve types, selection and protection. "How to know valves" covers four main types of valves from the standpoints of their appearance, inside construction, service intended, operation and use. "How to select valves" discusses five major factors involved in the choice of a valve — fluid, temperature, pressure, size and function. "How to protect valves" — written in "do and don't" style covers 11 important points in valve installation, operation and maintenance. R-P & C Valve Div., American Chain & Cable Co., Inc.

234 Valve Chart — Form 194, 24 pp, is a valve comparison chart, listing valve figure numbers of 15 major manufacturers and the OIC equivalent valve figure numbers. Compares variety of valves in ferrous and non-ferrous materials, describes different valve lines. The Ohio Injector Co.



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WORTHINGTON

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235 Industrial Valves — Condensed Catalog 105, 28-pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations describing non-return (stop-check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines. Also included is company's Mudwonder valve for abrasive fluids. Edward Valves, Inc.

236 Pump Valves — Key features of company's line of pump valves are outlined in 6-pp Bulletin V-112. Includes cutaway view showing design features, standard materials table, and a table of standard pump valve sizes. Sims Pump Valve Co., Inc.

237 Choosing the Right Valve — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in non-technical language, how each of these valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics are discussed and illustrated. Crane Co.

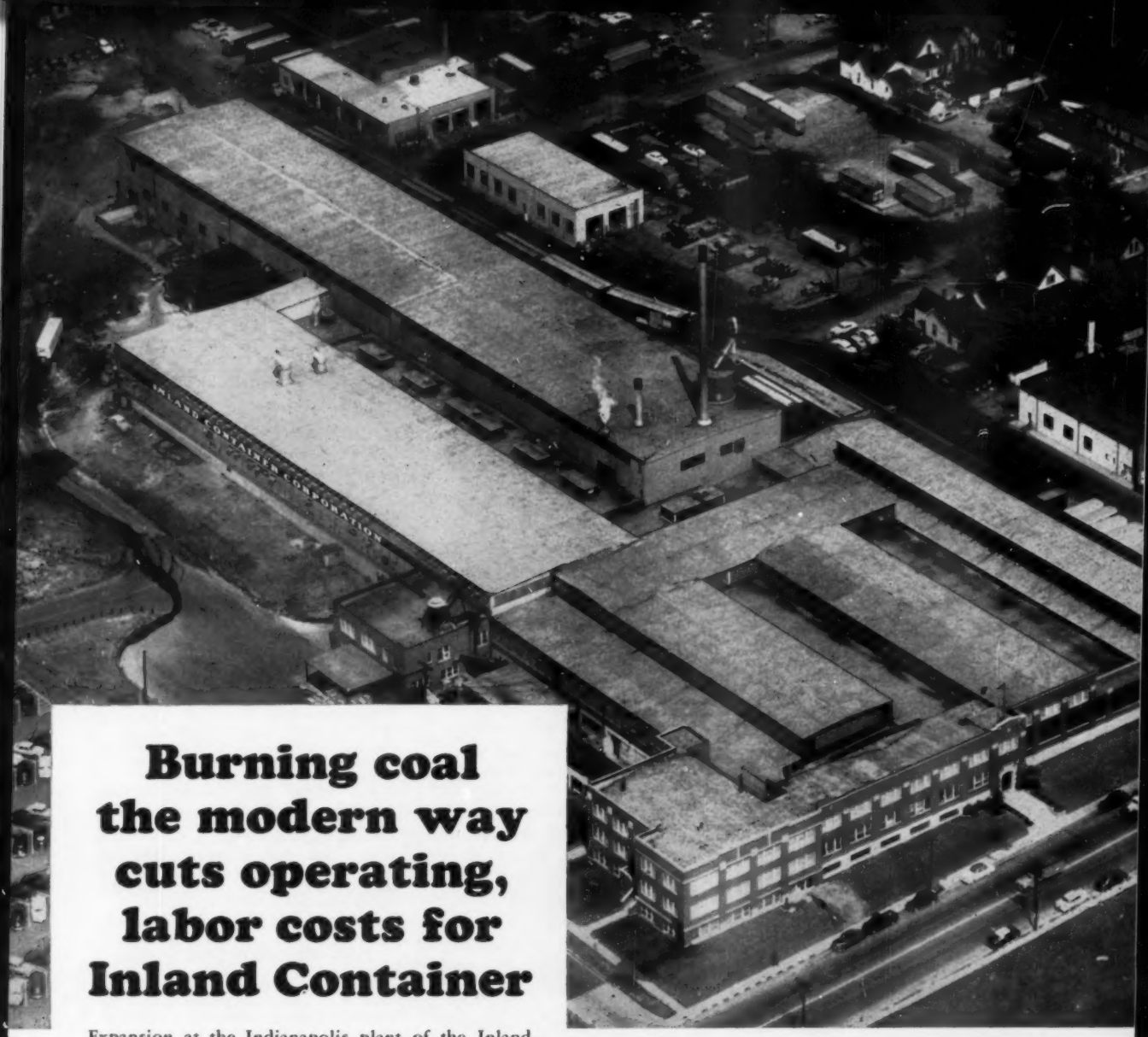
238 Steel Gate Valves — Four types of Hancock general purpose steel gate valves for process and power piping systems are described in illustrated Bulletin 202 C, 12 pp. Material specifications, dimensions given, also service pressure ratings. Manning, Maxwell & Moore, Inc.

239 Steam Trap Selector — Twelve-pp Bulletin T-9 is designed specifically to aid in selection and application of steam traps on chemical processing equipment. Features a foldout piping diagram for 22 pieces of typical processing equipment — each showing recommended steam trap and piping arrangements. Also contains selector tables. Yarnall-Waring Co.

240 Steam Trap Book — Catalog J, 44 pp, serves as a manual of trapping practice. Includes a catalog section giving physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes of equipment; a maintenance section explaining trap installation, as well as trouble-shooting and repair. Armstrong Machine Works.

241 Expansion Joints — Rubber expansion joints for relieving strains and stresses in piping, absorbing vibration, and eliminating noise are the subject of 8-pp Form AD-137. General advantages of rubber expansion joints are presented, and spool-type, U-type and rectangular-type joints are described as to construction and intended services. Also provided is catalog sheet on all-Teflon joints and Teflon-lined rubber joints. The Garlock Packing Co.

242 Flexible Ball Joint — Catalog 215-B, 20-pp, describes advantages of company's flexible ball joints for use in piping for power, process, heating, chemical, construction, or hydraulic service. Includes engineering specifications and data on the standard 300 lb series and the series 600. Screwed, flanged and welding end joints are listed, as are insulating joints and jacketed joints for handling asphalt and other liquids that solidify unless heated. Barco Mfg. Co.



Burning coal the modern way cuts operating, labor costs for Inland Container

Expansion at the Indianapolis plant of the Inland Container Corporation required additional steam capacity. The expansion was complicated by the limited space available. Inland's Engineering Department, with the assistance of W. J. Barrows & Associates, Engineering Consultants, solved the expansion problem.

Today the power plant has a new 30,000 lb.-per-hr. boiler and also a 300-ton silo. Liberal use has been made of automatic controls; coal and ash handling have been completely mechanized. Now steam loads are adequately maintained. Boiler room performance has been highly satisfactory and economical. Furthermore, this modernization has enabled Inland Container to effect considerable savings by more efficient operation of its power system.

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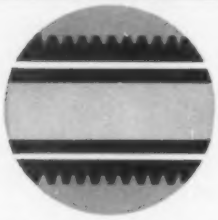
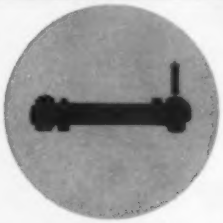


Extended tube surface — Greatly increases heat transfer capacity.



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PUMPS, COMPRESSORS

243 Controlled Volume Pumps — Bulletin 953, 24-pp, describes and illustrates use of controlled volume pumps in industrial water treating systems. Construction and operation features are described, capacity-pressure ranges and speed and stroke length adjustments are charted. Typical chemical feed and water treating systems are presented through text and diagrams; and an analysis of boiler water treating systems, cooling water treating problems, and systems for waste and sanitary water treatment included. Milton Roy Co.

When ordering catalogs, allow time for us to relay your requests to the manufacturers—and for them to mail out copies. Remember, manufacturers are often swamped with catalog requests.

244 Steam Pump Care — Bulletin G-2280, "How to Install and Take Care of Steam Pumps," is a 24-pp booklet containing a step-by-step series of 88 illustrations showing how to increase the service life of all types of steam pumps. It offers 28 tips on proper installation of the pumps, 54 tips on care techniques. Section on installation provides information on suction, packing the pump, starting it, and trouble shooting. Section on maintenance deals with such subjects as steam valves, liquid piston and rod, piston packing, liners, gaskets and many others. Worthington Corp.

245 Meter that Pumps — Bulletin 300, 8 pp, describes company's improved meter that pumps — designed for precise metering and proportioning of small quantities of low viscosity fluids at low cost, over extended periods of time. Complete capacity tables and a detailed schematic are also included. Hills-McCanna Co.

FUEL BURNING EQUIPMENT

246 For Burning Refuse Fuel — This 8-pp bulletin describes refuse fuel burning equipment, including a pneumatic refuse fuel distributor which spreads refuse fuels such as bark, wood chips, and bagasse uniformly over the grate surface. Discusses construction features of various components. Riley Stoker Corp.

247 Automatic Burner — Bulletin 420 contains approximately 30 pp of engineering data on a new burner unit for gas, oil or combination firing and sized for capacities to 42,000 lb of steam per hour. Separate sections of this looseleaf manual are devoted to photos and discussion of special features of the burner, general specifications, parts list, wiring and piping diagrams, explanation of operating sequence, and performance data. Available to qualified power engineers, please state your job title when requesting this bulletin. Peabody Engineering Corp.

248 Oil and Gas Burners — Bulletin OB-53, 28 pp, gives principles of selection and application of oil or gas burners, or a combination of both for standard and wide capacity range operation, together with air registers and fuel oil heating and pumping sets. Conversion table shows approximate relationships between quantity

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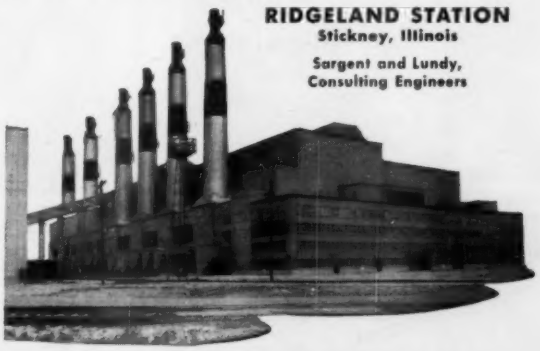

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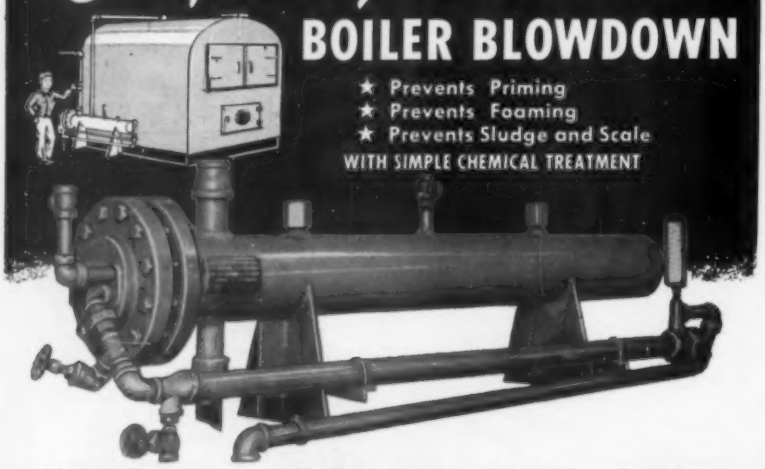

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of oil burned, boiler capacity and air required for combustion. The Engineer Co.

COAL, ASH HANDLING

249 Tractor Shovel — The engineering, design and production stories of company's HD-11G tractor shovel are pictorially presented in 8-pp Catalog MS-460. Includes specifications and describes various features which mean easier servicing for less time-down and greater operator comfort. Allis-Chalmers Mfg. Co.

250 Spreader Stoker — Sixteen-pp Bulletin 800 describes manufacturer's Type C-C RotoStoker, a relatively small spreader stoker offering continuous cleaning and ash discharge advantages of larger units, without need of a basement for ash-removal. Explains this and other operational advantages of the stoker, which is adapted to modern steam boilers with output capacities to 75,000 lb of steam per hour. Detroit Stoker Co.

251 Improved Crushers — Bulletin 12-C, 16-pp, describes company's line of crushers for reducing coal, coke, glass cullet, gypsum, lime, metal turning, sugar, sulphur and similar lump materials. Covers Knittel ring type crushers, two-stage double-roll crushers, single-roll crushers, and double-roll crushers. Photos, dimensional drawings and full specifications are included. Stephens-Adamson Mfg. Co.

252 Coal Crusher — Company's WC and WS series rolling ring coal crushers are described in Bulletin 154. Emphasizes special construction elements that mean greater coal reduction at lower operating costs. Cross section illustration shows both feeding and crushing action incorporated and tables give capacities, speeds, and dimensions. American Pulverizer Co.

253 Why Liquid Diffusion — What liquid diffusion can do for power plants is explained in Form B, which tells how liquid diffusion compounds work and gives four practical applications. These include dust control in coal handling, fly-ash control, coal storage pile treatment and boiler cleaning. Johnson-March Corp.

TUBING AND ACCESSORIES

254 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads. Roto Div., Elliott Co.

255 Life Extension for Condenser Tubes — The 32-pp current edition of this booklet reports on research into the causes of corrosion and means of combating them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in some circumstances. Revere Copper and Brass, Inc.

257 Tube Tools — Eight-pp Bulletin 58 describes advantages and application of company's line of tube cleaners, tube expanders and maintenance tools, including drills, brushes, accessory and specialty tools. Photos are included, as well as size and selection data. Airetool Mfg. Co.

258 Heat Exchanger Tubing — Cited in this 30-pp catalog are typical cases where cupro-nickel or Monel tubing installed in heat exchangers resulted in substantial savings and better efficiency

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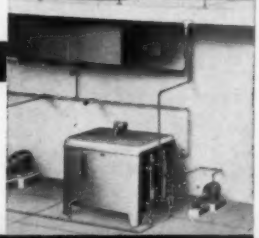

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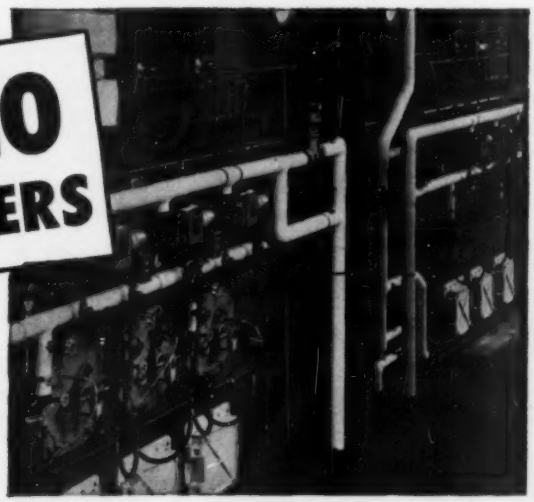

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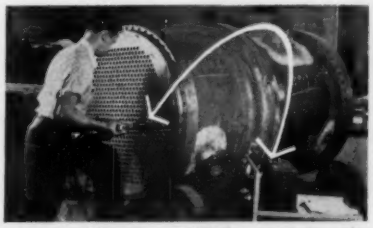

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through longer tube life. Describes applications of this tubing in various instances where unusual water conditions, as to pollution, excessive turbulence, temperature and the like, required tubing that would withstand this rigorous wear. The International Nickel Co., Inc.

OTHER EQUIPMENT

259 Refractory Concrete — Basic information on recommended practice for mixing and placing refractory concrete, used in the metal, power, ceramic, and petroleum refining industry as a material to withstand service temp to 2600 F or more, is presented in this 16-pp manual. Sections are devoted to special properties of refractory concrete, aggregates, refractory insulating concrete, and structural design. Universal Atlas Cement Co.

260 Centrifugal Dust Collector — Twelve-pp Bulletin 100 introduces the Cyclo-trell multiple tube dust collector which operates on centrifugal collection principles and incorporates new features to boost collection efficiency and gas handling capacity. An illustrated explanation of operation and construction of this collector is accompanied by collection efficiency and capacity nomographs. Tables give design data for six sizes, from three to 20 tubes. Research-Cottrell, Inc.

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4

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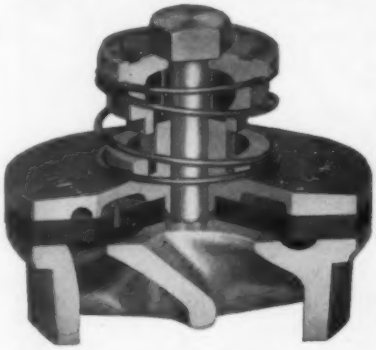

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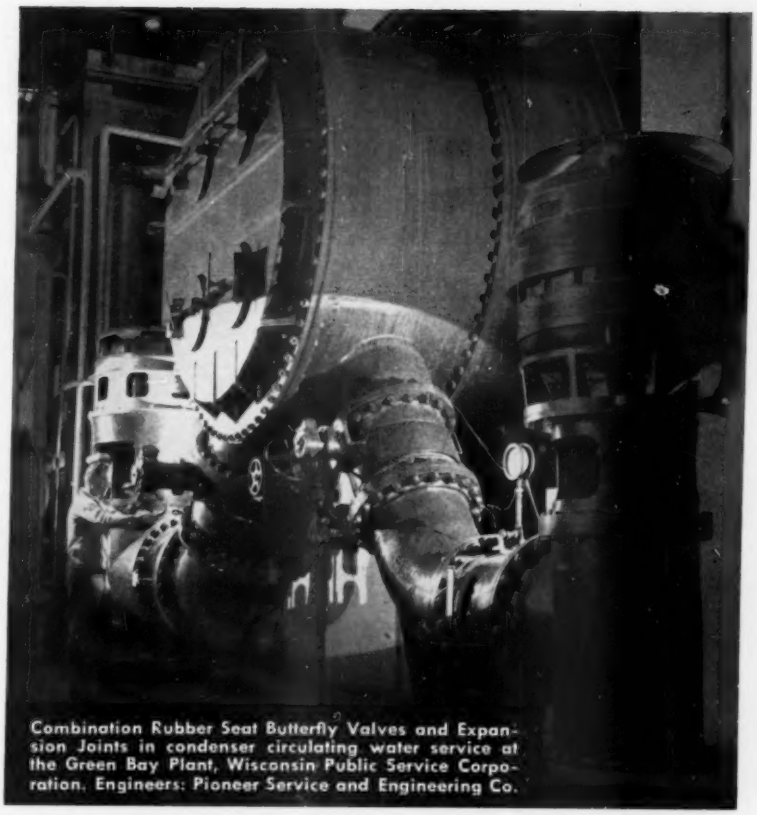

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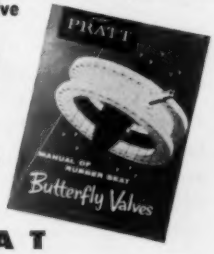

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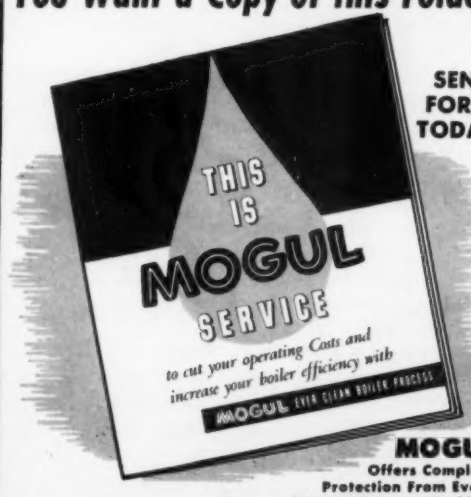
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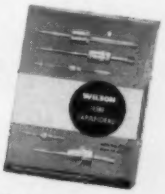

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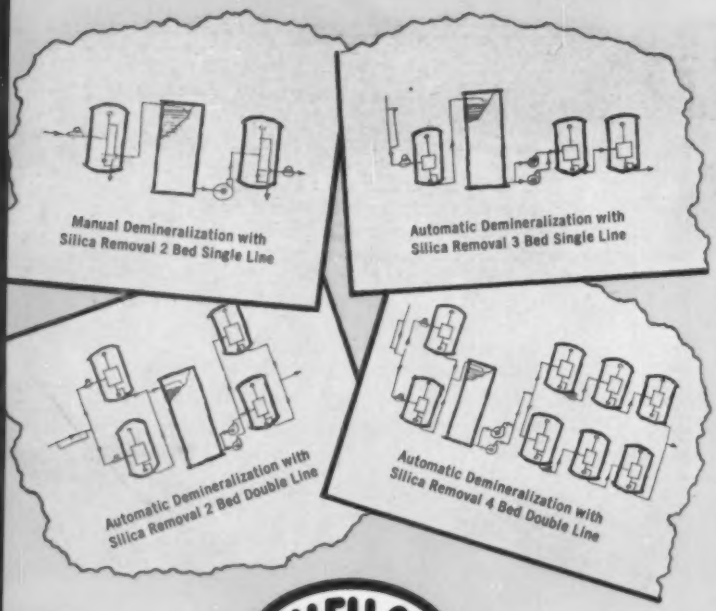
*INFILCO demineralizers are custom-built to solve the specific problems of each power plant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*The one best design for equipment to demineralize boiler feed water make-up depends on the characteristics of the water to be treated, boiler pressure and design, quantity of make-up required and many other variables peculiar to each installation. The best solution for one plant may be a manually operated two-bed demineralizer; in other cases three-bed, four-bed or mixed-bed demineralizers—manual or automatic—may be indicated.

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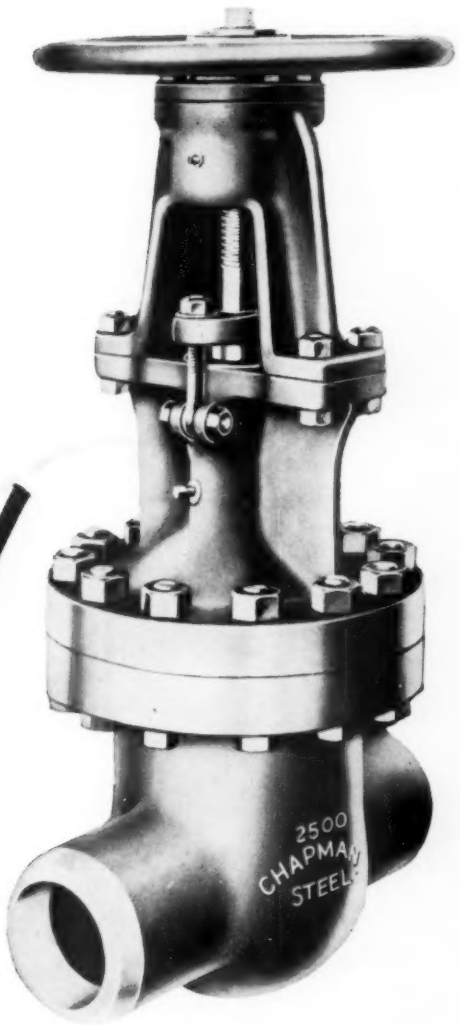

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